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IN ALL ITS APPLICATIONS TO

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SIR WILLIAM CROOKES, D.Sc., F.R.S., &c.

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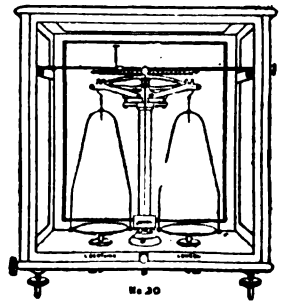

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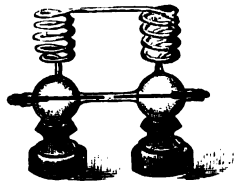

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VOLUME XCV.

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No. 2458.—JANUARY 4, 1907.

NIOBIUM, TANTALUM, AND TITANIUM:

OBSERVATIONS ON.

By W. B. GILES, F.I.C.

THE study of these metals has acquired additional interest through the remarkable researches of W. Bolton and M. Feuerlein, of the firm of Messrs. Siemens and Halske, who have achieved a veritable chemical and metallurgical triumph in transforming tantalum from the state of powders of doubtful composition and purity into metallic ingots, sheets,* and wire of great tenuity, and endowed with very remarkable properties, such as excessive hardness and great resistance to chemical agents; according to these gentlemen, tantalum in its chemical properties approaches the noble elements. It can hardly be doubted that tantalum before long will be obtainable in the shape of weights, crucibles, basins, and other utensils for laboratory use, and that in such forms it will prove to be of great value. It may be objected that owing to its rare occurrence its price must always remain very high, but experience shows that demand soon created a supply in the case of thorium, and already tantalite and columbite are available to the extent of many tons. From accounts which have reached the writer, large quantities of tantalite exist in the northern territory districts of South and West Australia.† It seems probable that the success of the tantalum lamp will enable this enterprising firm to recoup itself for the very considerable expenditure that these researches, extending over several years, must have entailed before any return was possible; in any case, great credit is due to these gentlemen for the very able manner in which they have brought the difficult subject of the metallurgy of tantalum to its present satisfactory condition.

From the date of the discovery of columbium and tantalum in 1801 by Hatchett and Ekeberg, a kind of romantic interest has been associated with these bodies, and probably more controversies and differences of opinion about their nature have arisen than with any other group of metals. It will suffice to recall that Wollaston in 1809 proclaimed the identity of columbium and tantalum. In 1846 H. Rose claimed that there existed three metals, viz., niobium, tantalum, and pelopium, and that after this Kobell contended for the existence of dianium, Hermann for ilmenium and neptunium, and Nordenskjöld for euxenium. So the matter remained in a state of uncertainty till the researches of Marignac, who sought to demonstrate that all the observed facts could be traced to the presence of three metals only, viz., tantalum, niobium, and titanium. Marignac's results have, as a rule, been received as a solution of the disputed points. Yet, in the opinion of some able chemists, it is doubtful whether his experiments were altogether conclusive. In 1880, Prof. Mendeleeff said (CHEMICAL NEWS, xli., p. 83):—"In my opinion it is in those numerous but insufficiently studied minerals, minerals with complex compositions, and containing titanium, zirconium, and niobium, that we should look for ekasilicon, *as well as for several other unknown elements.*" The great resemblance between the properties of ekasilicon and titanium allows us to suppose that ekasilicon has escaped observation, although it was present in titaniferous minerals; the difference of the results relative to the equivalent of titanium leads to this supposition. To determine the atomic weight of titanium, Rose (*Pogg. Ann.*, xv., p. 145), Pierre (*Ann. Chim. Phys.*, xx., p. 257), and Demoly (*Ann. Chim. Phys.*, xxii., p. 213) decomposed $TiCl_4$ by water, and having weighed the Cl present they obtained the following results:—

Rose	From	48·08 to 48·48
Pierre	„	50·34 „ 49·55
Demoly ..	„	57·3 „ 55·90

It is difficult to attribute such a want of concordance to differences and errors in the processes of research of the different investigators; we should rather admit that the $TiCl_4$ contained foreign unsuspected matter.* . . . "I would mention that on several occasions new elements have been supposed to have been discovered in the compounds of titanium, niobium, and zirconium, and some researches lead us to think that ekasilicon might have been present in some cases. We know that Hermann believed that he had discovered ilmenium, although Marignac (*Archives des Sciences Naturelles*, January, 1866, and August, 1867) showed later on that the columbites, which had been suspected of containing ilmenic acid, in reality only contained a mixture of titanic, niobic, and tantalic acids. To confirm Marignac's assertion, which was that Hermann's ilmenic acid was only a mixture of titanic and niobic acids, we can say that the equivalent of ilmenium found by Hermann occupies the place between the equivalents of—

$$\mathrm{Ti}\left(12\,\frac{48}{4}\right) \text{ and of } \mathrm{Nb}\left(19=\frac{94}{5}\right).$$

* The author is indebted to the courtesy of Messrs. Siemens and Halske for the gift of two pieces of pure sheet tantalum. In hardness and general appearance it closely resembles iridium, except that the tantalum is not quite as white in colour.

† *Opening up an Australian Goldfield.*—Developments of the Pilbarra Goldfields in the northern territory of Western Australia are at present in their infancy, and, considering the isolation of the fields, this is not altogether surprising. Tantalum-bearing ores have been worked, and up to the end of 1905 71 tons, valued at £8925, have been raised.—*Times Financial Supplement*, Dec. 24, 1896.

* Kokscharoff has described under the name ilmeno-rutile a body analogous to rutile but which has the density =4·8, whilst ordinary rutile has the density 4·2.

But Marignac himself has not succeeded in finding an exact method for the separation of titanic from niobic acid; he himself admits that his process (based upon the difference of solubility of the double fluorides of potassium) is insufficiently complete. We have therefore a perfect right to be sceptical of the exactness of his results, however reasonable they may seem, and I further hold that a repetition of his work would not be superfluous, more especially as Ti and Nb can be separated in the form of chlorides, compounds whose boiling-points show considerable differences." In 1886, Mendeleeff's brilliant prediction of the existence of ekasilicon was verified by the discovery of germanium by Clemens Winckler, and a little later on his surmise that this body would be discovered in certain minerals containing tantalum, niobium, and titanium was also verified (Krüss and Nilson, *Ber.*, 1887, xx., 1696). Prof Moissan in his "Traité de Chimie Minerale," vol. ii., p. 561, says:—"Germanium is one of the rarest of the elements; however it seems to be diffused in many of the minerals containing niobium and tantalum. The absence of sufficiently delicate analytical reactions is unquestionably a predominating cause for the want of success in the search for this element in minerals which may contain it in small quantities. Germanium has been found in euxenite (Kroutschoff, *Journ. Soc. Chem. Russ.*, 1892, 130), samarskite, niobite, tantalite, and gadolinite." In 1887, Krüss and Nilson (*Œfvers af k. Swenska Akad.*, 1887) investigated the acids contained in fergusonite on the lines indicated by Marignac. Their results showed that by following this chemist's instructions they were unable to obtain any fractions which agreed with the formula of a pure niobium potassium oxyfluoride, the first obtained crystals showing an atomic weight for the acids superior to niobium, and in which they could not detect tantalum, while the last obtained crystals showed in the acids a much lower atomic weight than that of niobium; the cause of this was found in great measure to be due to the presence of titanium. They point out that when titanium and niobium occur together their double fluorides with potassium possess quite different solubilities in water to what they possess when taken singly, and that a separation of the bodies by this method is hopeless. They suggest that there are three acids present, one having a higher atomic weight than niobic acid, *which is yet not tantalic acid*, and one lower which they found to be titanic acid. It is possible that the body with the atomic weight higher than niobium may be one of the still missing bodies pointed out by Mendeleeff; this would have an atomic weight of about 100, and would just fill the gap pointed out in his tables of periodicity above molybdenum. In this connection it may be mentioned that the author in working upon yttrotantalites and Australian tantalites has obtained on more than one occasion acids, both hydrated and anhydrous, of a very decided blue colour; when these acids were ignited the blue colour became somewhat duller. In these blue oxides no tin or tungsten could be detected; *they were not products of reduction*; for heating with concentrated nitric acid did not alter the colour, nor did very long continued heating over a powerful blast-lamp have any effect in oxidising them to colourless bodies.

The further investigation of these three metals has been undertaken with much energy and perseverance by American chemists, and notably by Dr. Edgar F. Smith, R. D. Hall, C. W. Balke, M. H. Bedford, C. H. Warren, M. E, Pennington, T. B. Osborne, and Dr. A. A. Noyes, and yet, notwithstanding the undeniable advance that their researches have achieved, it is admitted that much remains to be done before the problem of satisfactorily separating these bodies can be said to be solved. In fact, Dr. Noyes says (CHEMICAL NEWS, xciii., p. 180):—"The quantitative separation in the wet way of the three elements, titanium, niobium, and tantalum, is also, we believe, still an unsolved problem. . . . It then remained to devise a plan for the detection of titanium and niobium. No satisfactory method of separation could be found." Mr. C. H. Warren says (CHEMICAL NEWS, xciv., p. 298):—"There appears to be, so far as the writer can discover, no method by which more than a rough approximation towards a quantitative separation of these elements can be effected." So by a consensus of opinion it is admitted that the accurate separation of these three bodies when they exist together is one of the most difficult problems in analytical chemistry. Separately they may be estimated with considerable accuracy, but when they are associated they exhibit such properties that they may be said to have lost their individuality.

The author having studied the literature of these metals, as far as they were accessible to him from the time of H. Rose forwards, has been led from time to time to test the accuracy of the methods that have been proposed for their detection, being induced to do this from observing that some of the statements made are inaccurate and some are contradictory. In a very recent work (Moissan, "Chimie Minérale," ii., p. 130), niobic acid is said, for instance, not to be reduced in a hydrochloric acid solution when alkaline fluorides are present, while in the same work, two pages further on, this very reduction is given for its estimation! Some of the methods proposed for the opening up of these rather refractory minerals have been studied, and also the best means for obtaining the three metals in the form of pure compounds. It is hoped that some account of what has been observed may be of interest to those who are workers in the same field. In the analysis of minerals containing these acids we obtain usually a white heavy precipitate which may contain all or any of them. It is very desirable to be able to ascertain quickly the nature of this precipitate, and to obtain, at any rate, a rough idea of the relative proportions of its constituents. It is well, also, to keep in mind the bodies that may occur in such minerals. We may encounter, for instance, tin, tungsten, antimony (not at all uncommon in Australian tantalites), lead, germanium, zirconium, tantalum, niobium, titanium, uranium, thorium, cerium, and the rare earth metals generally, besides the ordinary matters, such as silicon, iron, aluminium, &c. It is a curious fact that if we consult ths latest edition of Dana's "Mineralogy," where the analyses of over fifty analyses of columbites and tantalites are given, many of these being of recent date, that in only one instance is the presence of titanic acid recorded, whereas the experience of Marignac, Dr. Edgar Smith, and others show that it is a common constituent of these minerals, and that in some of them at least it occurs in rather considerable quantity. This also agrees with the experience of manufacturers who, since the developments of Messrs. Siemens, Halske, and Co., have worked up considerable quantities of tantalites and columbites.

Assuming, however, for the sake of clearness that we have obtained the heavy white precipitate from the fusion of the mineral with an alkaline bisulphate or in any other convenient manner, and that we are only concerned with the detection therein of tantalic, niobic, and titanic acids, we proceed to test it in order to distinguish the three bodies. Putting aside the methods described by Levy and others, which employ various alkaloids, pyrogallic acid, &c., in conjunction with strong sulphuric acid, as they have been shown by Dr. Edgar Smith to be unreliable, we are compelled to rely upon the fact that these three acids exhibit different reactions when treated with reducing agents. It seems to be generally conceded that tantalic acid cannot be reduced in the wet way to any lower form of oxidation. Niobic acid under similar circumstances is reduced to blue or brown compounds, while titanic acid also yields violet or brown bodies. However, if such tests are made in the ordinary way described in the text-books, difficulties are at once encountered, If the three acids are fused with alkali, treated with hydrochloric acid, and then with zinc as is generally indicated, we do not obtain any decisive result unless the niobic or titanic acids are present in relatively large amounts to the tantalic acid, and even if tantalic acid is absent it is often difficult to distinguish between the colours yielded by niobic and

titanic acid. This experience will no doubt be familiar to those who have tried the test. Prof. Joly ("Encyclopedie Chimique," iii., p. 13) says, when speaking of this reduction:—"Cette coloration ne se produit pas avec un acide niobique tantalifère." The reasons why this process is unsatisfactory seem to be evident and to be three in number:—

1. The acids are for the most part precipitated *in an insoluble form.*
2. In this *insoluble form* the acids appear to have the property of combining with the reduced oxides as fast as they are produced, forming possibly, for instance, such substances as niobous-tantalate (?), $Nb_2O_3Ta_2O_5$. If we take, for instance, niobic acid and add a large amount of tantalic acid, and test it as above described, we realise Prof. Joly's experience, and instead of a blue solution obtain merely a slate-coloured precipitate.
3. The fact that the acids are for the most part in an insoluble form makes the reduction with rod or granulated zinc a very slow process, and thus gives every facility for the formation of the insoluble compounds alluded to in No. 2 as well as for the absorption of oxygen from the air.

It is thus evident that to make this test a really practical one we must—

First.—Effect the reduction as quickly as possible.
Second.—Obtain *all* the acids in a soluble form.
Third.—Modify the test in some way so that niobium and titanium may clearly be distinguished.

When these conditions are realised the tests become very delicate and satisfactory. Moreover, the saving of time effected is very great; decisive results are obtained in a few minutes which cannot be obtained in hours (if at all) when the old methods are employed.

(To be continued).

CHINESE TIN.

By FRANK BROWNE, Government Analyst, Hongkong.

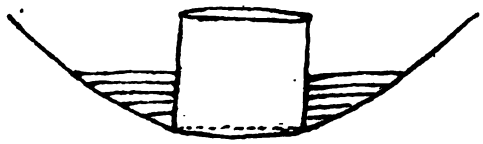
From Chinese information it has been ascertained that from 4000 to 6000 tons of tin arrive annually at Hongkong from the mines of Yunnan. The greater part of this is received during May, June, and July, when the West River is high enough for the carriage of the metal. The tin as imported is usually in flat rectangular plates, 1 in. thick, 2 ft. long, and 1 ft. wide. There are three qualities, of which the first and second are sometimes equal to those given below, but the third contains sometimes more than 20 per cent of lead. Most of the tin after importation is refined at the native refineries, of which several have been set up here in recent years. The arrival of tin from Chinese mines was first noticed in Hongkong in 1902. Three qualities are exported from Hongkong, and the following table shows their composition:—

	No. 1.	No. 2.	No. 3.
Tin	99·5—99·8	98·6—99·3	95·0
Lead	0·1—0·4	0·1—0·7	4·0
Antimony	0—0·1	0·02—0·3	0·02—0·3
Price per picul of 133⅓ lbs. in 1906 (dols.)	98—99	95—96	93—94

It is stated that about 70 per cent of the tin exported is of No. 2 quality. A good deal of the metal goes to Shanghai and other northern Chinese ports; the balance is exported to Germany, England, and the United States.

Chinese Refining Process.

The plant for refining consists of a round iron pan, concave, 3 ft. across by 1 ft. deep, having in its centre, but not attached to it, an iron cylinder open at both ends, 1 ft. high and 1 ft. in diameter. Two of these pans, imbedded in brick-work, are placed side by side. They are heated from below by means of billets of wood. A filter layer 5 in. thick composed of the dross from former tin meltings, is attached to the cylinder in the first pan. The cylinder in the second pan has no filter, as this pan is used only for the separation of tin from dross, for which operation a filter is unnecessary. Tin is put into the first pan, and the molten metal is allowed to filter into the cylinder. A quantity of purified metal soon collects. This is "tossed" and skimmed, and the skimmed liquid is then ladled into moulds. The ladle holds about three pints of liquid, and each ladleful in the mould is at once skimmed; about three ladlefuls are sufficient to fill one mould. The skimmings of the metal in the first pan and cylinder are put into the second pan, and a further quantity of purified



Chinese Tin Refining Pan,
Showing filter of dross attached to the cylinder.

tin is collected in its cylinder. From time to time when no more tin runs, the semi-solid dross in the first pan (except the filter dross attached to the cylinder) is transferred to the other pan, and more tin is put into the first pan to be melted as before. During the refining a small ingot is cast, and from its general appearance the quality of the tin is judged. The dross is finally cut out from the second pan into slabs of about 10 lbs. weight. These slabs are heated with charcoal in a wind furnace, and the resulting metal allowed to run off into a hole. From this hole it is transferred to the melting pans to be purified. The residue from the second or charcoal purification is a dark brown porous solid, inclined in parts to fall to powder. It consists mostly of metallic iron, with some tin, lead, silica, sulphur, and charcoal, and small quantities of arsenium and antimony. No tungsten, bismuth, copper, silver, or gold is present. This is sold to buyers at Shanghai at 10 dols. a picul, where it is said more tin is extracted, and the residue therefrom made into iron articles.

Analysis of Chinese Tin.

Five grms. of drillings are treated in a flask with 50 cc. of nitric acid (about 1·3 sp. gr.), and when all action has ceased, the flask contents are transferred to a basin, and evaporated over a water-bath to complete dryness. The residue is boiled several times with water to dissolve out lead, until the filtered washings do not darken with ammonium sulphide. The residue is then boiled with a 5 per cent solution in water of pure tartaric acid to dissolve out any antimony, and the residue, after transferring to a filter, is washed three or four times with boiling water. The tin residue is then dried, gently incinerated, allowed to cool, and 1 cc. of nitric acid is poured over it. After very gently heating for a few minutes, the crucible is blasted in the usual manner, and the tin weighed as oxide. The lead in the washings is estimated either as sulphate, or when the quantity is small, the washings may be treated with a drop of ammonia, then acidified with acetic acid, and the lead estimated colorimetrically by sulphuretted hydrogen. It must not be forgotten, however, that arsenic acid, iron, and zinc may occur with the lead in the washings. The tartaric acid washings are nearly neutralised with ammonia,

and the antimony is then best estimated by comparison with an antimony solution containing 1 mgrm. of antimony in 1 cc. of 5 per cent tartaric acid solution, both of which are heated and treated with sulphuretted hydrogen. The amount of antimony sulphide is usually under 10 mgrms., and this method for minute quantities of this metal has been found more satisfactory than gravimetric methods.

The above is not a new process, but the method of procedure therein specified has been found very useful for Chinese tin. A little care is required in washing the tin oxide, but the filtrate after returning once to the filter usually comes through quite bright. Care should be taken with the washings containing the lead, so that they may if necessary be searched for any loss revealed by the analysis. If the first gentle incineration of the tin oxides be omitted before adding the nitric acid, the oxide after blasting may not be of a uniform colour. This darkening in parts is due to the action of a trace of tartaric acid remaining in the oxide.

SOME SOURCES OF IMPURITIES IN C. P. CHEMICALS.*

By J. W. SCHADE.

The elimination of impurities in chemically pure chemicals has long been the desire of chemists; but owing to a seeming indifference on their part, the manufacturers have not exerted themselves to make their products better than they deemed absolutely necessary to meet the demands. During the past year or two much increased interest has been manifested in the movement to secure the best grade of laboratory reagents consistent with economy in manufacture. To ask for a reagent "absolutely pure" is to ask, in most cases, for the impossible in economical manufacture. The object of this paper is to present some sources of impurities in chemical reagents and to point out that there are limits of purity obtainable by manufacturers.

With few exceptions all reagents are shipped in glass containers. The dry salts probably do not take up impurities from the bottles, but acids and ammonia after standing in containers for a few days are contaminated with impurities from the glass. These impurities may be one or more of the following:—Iron, potassium, sodium, silica, calcium, and from bottles of Jena or "Nonsol" glass, zinc. In the case of ammonia, silica is the principal impurity from the glass; in the case of acids, iron. The latter is due mainly to the fact that small chips of iron oxide flake from the blowpipes used by the glassblowers, and although acid is allowed to stand in the bottles before they are washed for use, there are undoubtedly minute particles that escape immediate solution. Acids shipped in carboys having glass covers secured by zinc rings are liable to contamination from the zinc, owing to the splashing of the acid into the neck of the carboy. Hydrofluoric acid shipped in lead carboys takes up that metal as an impurity. The nature of these impurities is such that the liability of contamination cannot be entirely removed, though it may be diminished by the use of more resistant glass and of glass-stoppered carboys.

The second source of impurities is in the chemical works. It is the vessels in which the chemicals are manufactured. These vessels—tanks, stills, condensers, crystallising dishes, and so on—are made or lined with lead, silver, copper, iron, aluminium, nickel, zinc, platinum, porcelain, earthenware, or glass. The impurities from this source are the metals of which the vessels are made, and from the non-metallic receptacles silica, sodium, potassium, calcium, and iron. Iron vessels give rise to other impurities than iron, notably manganese. In the manufacture of sodium bismuthate, for instance, iron vessels cannot be used, owing to the contamination of the product with manganese, which, of course, is inadmissible in that reagent. Nickel is found in the best grades of caustic alkalis from the dishes in which they are made. Copper, aluminium, or silica are found in acetic acid from the condensers used in the distillation. Lead tanks are very generally used, especially for crystalising organic acids such as tartaric and citric. The author has also found it in hydrofluoric acid, ammonium chloride, potassium sulphate, and sodium chloride. The amount of impurities of this class is minimised by the judicious selection of vessels to meet the needs of each case. As with the first class, however, the liability to contamination cannot be entirely removed.

There is another class of impurities introduced during the purification of the salts. These impurities are reagents used to precipitate certain foreign substances or the salts formed by the reaction. For instance, the author once analysed a sample of sodium chloride in which sulphate had been precipitated by means of barium chloride. This salt gave decided tests for both barium and sulphate, an anomalous condition often met in testing reagents. Another example of this is the presence of calcium in ammonium oxalate. Samples of ammonium oxalate giving clear solutions sometimes contain some hundredths of a per cent of calcium though the solution from which the crystals were obtained was alkaline. It is evident from these facts that the so-called "insoluble precipitates" are dissolved to an appreciable extent by the concentrated solutions from which the salts are crystallised.

The final class of impurities includes those occurring in the original source of the chemicals. *i.e.*, in the minerals, and in those substances used in manufacture. These impurities will vary in number and kind, depending on whether the treatment of the mineral is simple or complicated. Sometimes it is impossible for the manufacturer to get rid of certain impurities without putting a prohibitive price on an article. Iron, alumina, and silica appear in all but the highest-priced grades of caustic alkalis and alkali carbonates. Nickel and cobalt cannot be entirely separated on the large scale cheaply. As has been pointed out above, calcium cannot be entirely removed from ammonium oxalate, strange as it may seem, without considerable trouble and expense. Again, strontium sulphate will not precipitate barium from a solution of strontium chloride or nitrate unless a large excess is added, in which case sulphate is introduced as an impurity. Here the manufacturer is compelled to choose the lesser of two evils. This is the inevitable alternative in many instances.

Calcium persists in barium salts, and if considerable calcium is present in the mineral from which the barium is obtained it is no easy matter to remove it. The removal of iron from copper sulphate is not as simple as one would imagine. Some of the "iron-free" copper sulphate sold on the market contains several thousandths of a per cent of iron. To separate the two iron must be in the ferric condition. Hydrogen peroxide is theoretically an ideal oxidising agent in that it introduces no impurity into the copper sulphate, but in practice nitric acid works somewhat better. Here is a case in which nitric acid is introduced as an impurity in preference to iron. Lead is sometimes found in copper salts and is difficult to remove from the chloride and nitrate. Ferric salts always contain free acid, fused magnesium chloride always contain ammonia, and caustic alkalis and alkali carbonates, as has been said, almost always contain iron, alumina, and silica.

These illustrations serve to show that at ordinary prices chemical reagents must be limited in purity. This, however, is not a serious difficulty except in cases when extraordinarily accurate work is to be performed; and the manufacturer can supply at a reasonable price reagents that will give accurate results when put to the ordinary uses. —*Journal of the American Chemical Society*, xxviii., No. 10.

* Read at the Ithaca Meeting of the American Chemical Society.

ON A NATURAL SYSTEM OF ARRANGING THE CHEMICAL ELEMENTS, IN WHICH THEY FALL INTO THE PERIODIC GROUPS, BASED SOLELY UPON THE ATOMIC VOLUMES AND THE COMBINING WEIGHTS.

By the late JAMES MONCKMAN, D.Sc.

ONE of the most interesting things in the whole course of chemistry is the law that the properties of the elements bear a periodic relation to their combining weights. But when this law is used for the classification of the elements there are some things that seriously detract from the satisfaction with which it is regarded; firstly, it does not give a fixed order for the groups; secondly, there is a certain irregularity, there being no representatives of the heavier elements in the first two lines; and, thirdly, the triplets Fe Co Ni, Ru Rh Pd, Os Ir Pt, are left out in the cold in an eighth column all to themselves. These have led to so much confusion that it is easy to read half-a-dozen different arrangements of the elements in as many different books on the subject.

Gold and platinum trouble some writers, while others take sodium out of the alkaline metals and place it at the head of the copper group, in order that these two may be of equal length, repeating the process with magnesium, &c., so getting an artificial regularity, but at the same time spoiling the natural order of the members of each group. Whereas, authors wishing to give special importance to some particular group simply transpose the whole so that the group in which they are interested may be first in order, or may occupy the centre, while they explain it by saying this is one of the ways in which the groups may be placed.

Now while variety is pleasing in art and decoration. it cannot by any means be considered so here, and therefore a method at once simple and effective, that will get rid of this confusion, should be welcomed, more particularly if it gives us reason for placing such bodiss as the triplets in a position of prominence proportional to their importance, and also arranges the other groups in situations relative to these, or to a fixed central line, such as their properties appear to indicate.

The first hint of the possibility of any such plan was given by a diagram showing the relation of the combining weights of the elements to the heat produced when they combined with chlorine, which was published by Laurie in the *Phil. Mag.*, [5], xv., 42. This was produced by marking off the combining weights of the elements upon the horizontal line in checked paper and the heat of combination upon the vertical line. In this way he got a series of points, which, being joined by lines in the order of their combining weights, gave the diagram required. Now instead of following Laurie's method of joining by lines in order of the combining weights, connect the elements of the same periodic groups, and seven lines are produced by joining Li, Be, B, C, N, O, F, or Cl to the other members of their own groups; and although these are somewhat wavy, they have a general kind of parallelism which at first impresses one with the idea that something new and important has turned up; but when the heavier metals are joined into groups, the lines, although parallel to each other, are not so to the previous groups, but cut across them in a confusing manner, completely dissipating any feeling of jubilation that the regularity of the first set produced. Here were two distinct sets of lines, the lighter metals and the heavier, but nothing more could be done to find out why they were similar and why they differed. They did a good thing, however, by rousing the attention to the possibility of the existence of an underlying system, but my search for it was without avail, until I read Prof. Lothar Meyer's account of the Atomic Volumes and their Relation to the Combining Weights and to the Periodic Law, when the full signification of the matter became apparent.

In his "Outlines of Theoretical Chemistry," Meyer gives a table of the elements arranged according to the periodic law, includes in it the densities of the elements, and the atomic volumes, which is of course calculated by dividing the combining weights by the density in each case, and he shows that the volume falls as the atomic weight rises to a certain point, after which they increase together. This he has also shown in a graph in which the combining weights are taken along the horizontal line and the atomic volumes upon the vertical one (Fig. 1).

The first curve is formed by joining Li, Be, B, C, N, O, and F together, and its lowest point is at c. The second line joining Na, Mg, Al, Si, P, S, and Cl, forms the second curve, but the whole is higher above the zero line. The third curve is larger, and the lower elements form a kind of basin-shaped depression in the lower part; the same occurs in the fourth. The fifth and sixth are imperfect.

The very great importance of the relationship expressed by this graph has apparently, escaped the notice of chemists, nor has the fact been perceived, that by a very slight alteration of the method of constructing the graph, the elements fell into such positions that the lines joining those of the same periodic groups form a series of concentric curves, thus deducing the periodic arrangement from the combining weights and the atomic volumes alone, and in addition producing a system symmetrical about a zero line.

Prof. Meyer drew attention to the fact that, "Where each curve changes direction from descending to ascending many important properties of the elements change also. Thus in the front part of the curve, where the volumes decrease as the combining weights increase, the elements are paramagnetic, malleable, and usually form stable compounds with oxygen, while in the other half or ascending portion the elements are diamagnetic, brittle, and the oxides are easily reduced."

It is therefore quite clear that the change in the curve indicates a change in some important characteristic of the elements in relation to the combining weights.

The curve is similar to that which is formed when a thermocouple is heated with gradually increasing temperature until the neutral point is crossed; thus if we take rods of copper and iron and form a couple, and, while keeping one end at 250° C. we vary the temperature of the other, and plot the quantity of electricity produced, a similar curve is formed descending to zero and then ascending with a changed sign. Now we know that the electrical state of each metal in this case can be represented by a straight line, and the action of the two together by two lines crossing at the zero point.

In like manner the atomic volume and the combining weights may be represented by lines crossing each other at the zero or turning point of the curve. By this means Fig. 2 may be produced. There is, however, another way of getting the same diagram which is more logical, and this consists in taking the combining weights as before, but plotting the tangents of the angles that Meyer's curves form with the horizontal line instead of the volumes. This causes the rising curve to be thrown upon the opposite side of the zero line, and when the elements of the same periodic groups are joined by lines, ten concentric curves are formed, each having the appearance of being part of an elliptical figure, with one side considerably flattened.

To get the elements in this diagram to arrange themselves in the order usually adopted in books, and the natural one for people writing from left to right, it is necessary merely to change the usual convention as to the signs and making the positive take the left side, and the negative the right, while the combining weights are measured upon the vertical or zero line. By this means Fig. 2 is constructed. (For explanation of Fig. 2 see p. 6).

These curves arrange themselves naturally into three sets, to which, for convenience of reference, the name Exionic, Endionic, and Central have been given.

The exionic lines are numbered 1 to 4 and constitute the four curves that cut the transverse lines AB and CD. Upon them are situated the lightest elements.

TABLE I.

First.—Both sides of the zero line are alike quantitatively.

ZERO LINE.

Left or + Side.	*Right or − Side.*
1. The atomic volumes decrease as they approach the zero line (Fig. 2).	The same takes place on this side.
2. Chemical affinity also decreases.	1, 2, and 3 fall, while 4 and 5 rise.
3. Power of producing heat when they combine with another element does the same thing.	
4. Melting points, and	
5. Atomicity rise.	

Second.—They differ qualitatively on the two sides.

ZERO.

1. Prof. Meyer gives the first four. As the atomic volumes decrease the combining weights increase.	As the atomic volumes increase the combining weights do the same.
2. The elements are paramagnetic (attracted by a magnet).	The elements are diamagnetic (repelled by a magnet).
3. They are malleable.	They are brittle.
4. Their oxides are stable.	Their oxides are easily reduced.
5. All the exionic elements are metallic except one.	All the exionic elements are non-metallic or semi-metallic except one.
6. They are electrically positive to those on the opposite side.	These are negative to those on the opposite side.
7. The affinity for oxygen is greater further from the zero line.	The affinity for hydrogen is greater further from the zero line.
8. Exionic oxides nearly always bases.	Exionic oxides mostly acids.

Third.—Their variations are symmetrical.

ABOUT THE ZERO LINE.

1. With the exception of the first two lines, they become gradually more distinctly metallic as they approach the centre.	The same thing takes place on this side also.
2. If the volumes of unit weights of the elements be plotted upon checked paper, with the combining weights measured in one direction and the volumes at right-angles, the diagram shows a series of concentric curves shaped like the outline of one-half of a Florence oil flask—that is, spherical in front, but tapering off behind.	The curves formed by the elements on this side complete the figures of the Florence flask. The whole forming a set of ten more or less perfect figures, symmetrical about the zero line and decreasing gradually in size. Somewhat similar to Fig. 2, but very much wider at C D and E F, and much closer at I J and K L.

3. Atomicity.

Exionic curves	.. ..	No. 1 are monads on both sides.
„	.. ..	No. 2 „ diads.
„	.. ..	No. 3 „ triads.
„	.. ..	No. 4 „ tetrads.
Endionic	.. .. ..	No. 5 „ triads.
„	.. .. ..	No. 6 „ diads.
„	.. .. ..	No. 7 „ diads. (On the negative side it is irregular, being both 1, 2, and 3).
Central	.. .. ..	All are diads.

4. Spectroscopic lines. Meyer's law (*Nature*, August 24, 1899, p. 394). If the wave-lengths for all the lines for N − be calculated and put as ordinates and the atomic weights as abscissæ, then all the points lie on a curve similar to that which gives the atomic volumes.

TABLE II.

Set	Exionic		Endionic		Central		Endionic		Exionic	
Rise or fall ...	Gradual		Gradual		Gradual		Gradual		Gradual	
	From	To	From	To	From	To	From	To	From	To
5. Density	1·1	4	7·5	11	14·1	13·9	13	8·3	7·9	2·7
6. Melting-point	350	1700	1500	1600	2200	1770	1300	760	480	240
7. Refractive equivalent .	9·3	14·6	24	11·7	17	16	16	20	20	9
			(Single elements).							
8. Specific heat of unit vol.	0·3	0·76	0·6	0·9	0·7	0·8	0·7	0·4	0·57	0·25
9. Atomic heat	6·7	5·9	7·4	6·7	6·3	6·3	6·1	6·2	5·9	6·1

EXPLANATION OF FIG. 2.

The dots represent the positions of the elements. The names of these upon each transverse line are as follows :—

Upon (A B)	Li	Be	B	C													C	N	O	F
„ (C D)	Na	Mg	Al	Si													Si	P	S	Ce
„ (E F)	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	————		Cu	Zn	Ga	Ge	As	Se	Be	
„ (G H)	Rb	Sr	Y	Zr	Nb	Mo					Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I
„ (I J)	Cs	Ba	La	Ce	Di															
„ (K L)					Ta	W					Os	Ir	Pt	Au	Hg	Tl	Pb	Bi		
„ (M N)				Th		U														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	10.	9.	8.	7.	6.	5.	4.	3.	2.	1.

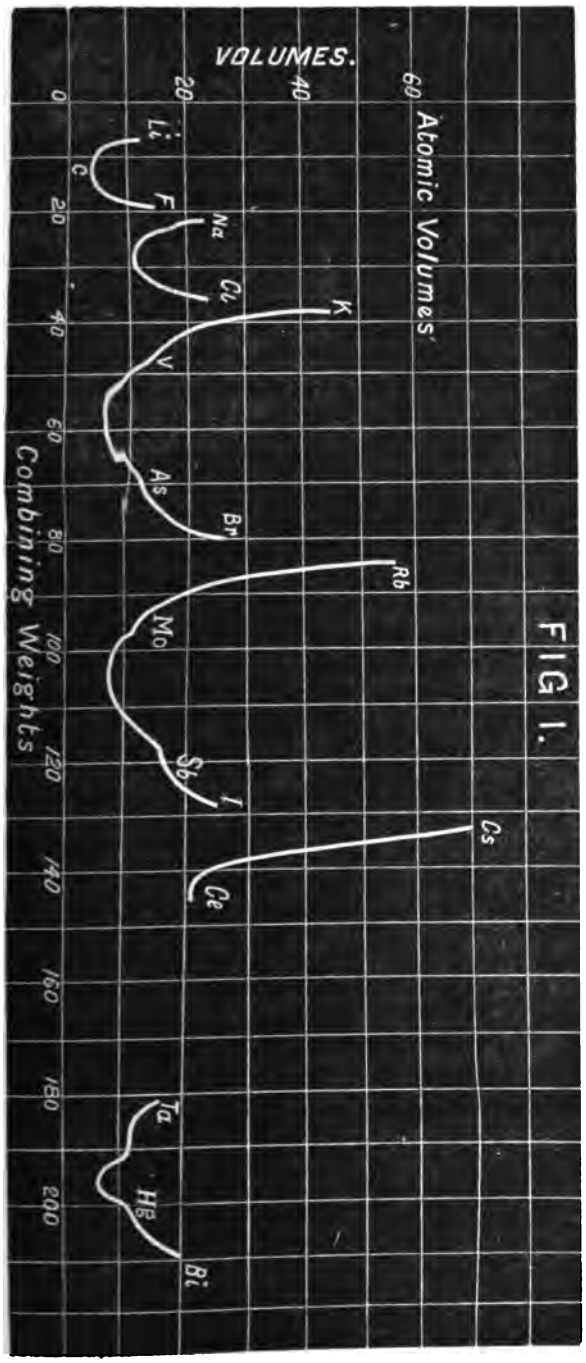

VOLUMES.
0
20
40
60 Atomic Volumes
Combining Weights
20
40
60
80
100
120
140
160
180
200
Li
C
F
Na
Cl
K
V
As
Br
Rb
Mo
Sb
I
Cs
Ce
Ta
Hg
Bi

FIG 1.

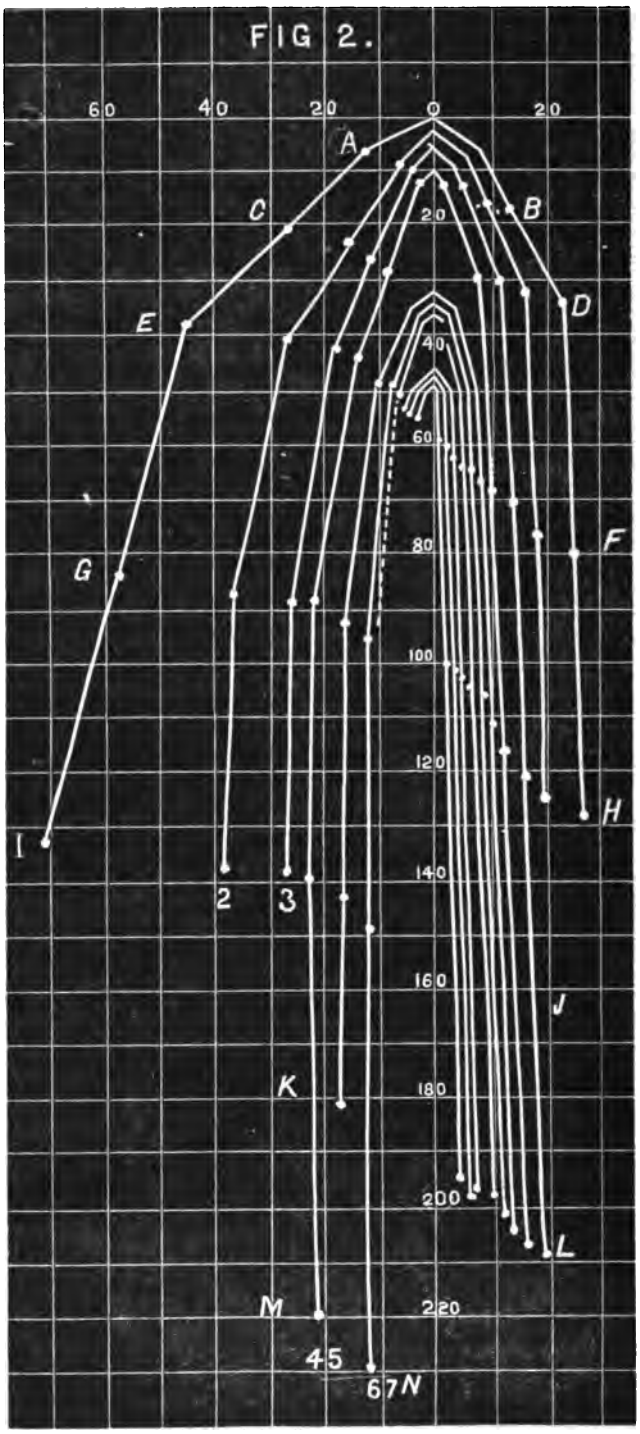


FIG 2.
60
40
20
0
20
A
B
C
D
E
F
G
H
I
J
K
L
M
N
20
40
60
80
100
120
140
160
180
200
220
1
2
3
45
67

The endionic numbered 5. 6, 7, are the three next within these, and they have the heavier elements; these curves do not cut AB.

The central consist of three lines near the centre containing the heaviest elements in each transverse line, and their natures are so closely allied that they are always put into one column; they form triplets Fe, Co, Ni on EF, Ru, Rh, Pd upon GH, and Os, Ir, Pt upon KL. The centrals are remarkable metals, at one end the most magnetic and at the other the densest and the most intractable. Outside the whole will be the curve upon which He and the other monads fall, occupying places beyond F, Cl, Br, and I, while H is upon the other side, alone, but spaces are left vacant for other elements with combining weights of about 5, 21, and 38.

This Natural System of Classification, while losing nothing that is good in the plans usually adopted with the periodic groups, has a great many advantages; in addition to fixing the positions of the lines it has three qualities that must be found in any perfect system of classification.

1. Bodies on opposite sides of the zero line should differ from each other in certain important qualities, and
2. Where their properties are capable of being expressed quantitatively they differ in the ratio of their distances from the zero line, or nearly so.
3. When sudden changes take place in passing from the Exionics to the Endionics and again to the Centrals they should, as a rule, repeat the process in the reverse order on continuing their way from the centre to the other side.

All these three are formed in the natural system, which is really the Periodic Law in its greatest simplicity applied to the classification of the elements.

This may be put into tabular form, as in Table I.

Consequently if these be treated in the same way as the atomic volumes in Fig. 2, a similar figure will be produced. with similar symmetry about the zero.

In order to get rid of irregularities produced by experimental errors, impurities, allotropic forms, or other chemical or physical changes, it is necessary to use averages of the members of each group and not to rely on single elements. In Table II. the averages of the first and the last group of each set are given and the way in which the averages of the intermediate members rise or fall is indicated by reading the head line for each. Thus, density in the exionic set, rise gradually from 1·1 to 4; atomic heat falls gradually from 6·7 to 5·9. The refraction equivalent (7) is taken from Gladstone's table in "Watts' Dictionary," iv., 227. In the case of the endionics V, Cr, Mn, only are given in the table, so that averages could not be taken, hence the rate of decrease is probably too violent. Generally, the change in the numbers is gradual in each set of groups, sudden in passing across the division line, frequently with change of direction afterwards, and the process is reversed on the other side.

In another paper I hope to show how these atomic volumes may be used to calculate the thermal equivalents by means of an equation involving the volumes of the elements before union, and of the salts after combination, together with a constant that varies from curve to curve in a fairly regular manner about the zero.

Although these are not all the lists that could be made, they are quite sufficient to show the extreme importance of the atomic volume and its great value as a means of obtaining a classification of the elements which is at once simple and inclusive.

Table III. is given in full to show how the figures in the foregoing list are obtained. It had, however, one additional characteristic that is worth noting: the horizontal averages for the exionic and for the endionic sets indicate some particular connection between the elements of the same line, which produce a constant average, and consequently whenever any single elements such as C and B have exceptionally high meiting points, the other elements of the line have proportionally low ones to compensate.

The averages of all the lines of the exionics lie between 600 and 700, but in the first line C is 2000 and B 1300;

TABLE III.—BOILING-POINTS.

Melting-points in Absolute Temperature.—H, 32; He, ?; Ne, 32; Kr, 121 (*a*), 164 (*a*).

(*a*) Includes Ta, W, &c., as there are no elements in the proper line.

Li	455	Be	1173	B	1300 ?	C	2000 ?																								
Na	369	Mg	873	Al	973	Si	1773																								
K	336	Ca	973	Sc	—	Ti	2000 ?	V	1500	Cr	1500	Mn	1600	Fe	1800	Co	1793	Ni	1673	Cu	1327	Zn	700	Ga	300	Ge	1173				
Rb	312	Sr	973	Y	—	Zr	1773	Nb	1500	Mg	1500			Rh	2300	Ru	2010	Pd	1773	Ag	1273	Cd	590	In	480	Sn	506				
Cs	299	Ba	1008	La	1073	Ce	1073	Ta	1500	W	1500			Os	2700	Ir	2100	Pt	1900	Au	1528	Hg	238	Tl	577	Pb	600				
	1771		5000		3346		8629		4500		4500				6800		5903		5300		4128		1567		1327		2279				
Av.	354		1000		1115		1726		1500		1500		1600		2233		1967		1770		1376		513		442		760				

N	91	O	91	F	150																										
P	317	S	387	Cl	168																										
As	773	Se	953	Br	266																										
Sb	696	Te	738	I	387																										
Bi	541																														
	2418		2169		971																										
	483		542		243																										

Horizontal Averages.

In outer exionic curves, or lighter elements—		In inner endionic curves, or heavier elements—		In central triplets—		For the whole line—		Differences.	Differences in combining weights.
Li line	660	V line	1150	Fe line	1773	Li	666	28	16
Na ,,	694	Nb ,,	1070	Ru ,,	2073	Na	694	36	16
K ,,	600	Ta ,,	1070	Os ,,	2300	K	1030	50	46
Rb ,,	660					Rb	1080	50	48
Cs ,,	700					Cs	1130		

these are counterbalanced by the very low melting points of N, O, and F.

Another point to be noted is similarity in the rise in the differences in the melting points and in the combining weights for the whole line.

The gradual rise of the numbers in the exionic with sudden fall on passing, then another gradual rise in the endionics with another sudden rise between them and the centrals where there is a gradual fall, the whole being repeated in the inverse order to the end, is well shown in the line of averages.

THE USE OF PORCELAIN DISHES IN SILICA DETERMINATIONS.

By F. L. KORTRIGHT.

IN the usual method for the determination of silica, after the substance has been gotten into solution, it is evaporated to dryness to render the silica insoluble. For this evaporation most writers recommend the use of platinum dishes instead of porcelain dishes without stating their reasons for so doing, but the opinion seems to prevail that the objection to the porcelain dish is the possibility of a portion of the dish going into solution and by this means increasing the amount of the silica. The first to call attention to the other possibility, that the porcelain might cause a loss of silica, was W. F. Hillebrand, who says (*Journ. Am. Chem.* xxv., 1192) "Were it not for the fact that similar deficiencies do not appear in their cement analyses, it might be thought that in some of the cases silica had adhered so tenaciously to the porcelain dish on evaporation as to escape complete removal. This is a cause of error quite likely to arise at times when using porcelain, because of the difficulty of seeing the adhering silica against the white surface." Later H. N. Morse says ("Exercises in Quantitative Chemistry", 311), "It is very difficult to distinguish small particles of silica upon a concave surface of white porcelain, and almost impossible, therefore, to determine whether a dish of this kind has been sufficiently cleansed."* So far as I can find in the limited literature at my disposal, no data has been published, however, showing the possible extent of the error which may be introduced into a silica determination through being unable to remove all the silica from the dish, and Dr. Hillebrand has informed me that he has not made any quantitative determinations of the amount of silica which might be thus lost.

The impression gained from both of the statements quoted above was that the silica escaped determination on account of its not being seen on the white porcelain, and not because it adhered so tenaciously that it *could not* be removed. The following, however, has to do entirely with the silica that it was not possible to remove from the dish by any ordinary means:—

For several years it has been noted in this laboratory that when porcelain dishes were used for this evaporation, a greater or less roughening of the glaze of the dish occurred at about the line where the surface of the liquid came at the beginning of the evaporation. Until recently we have believed that this roughening was caused by the action of the solution on the glaze of the dish, although no attempt was made to find if this were true. The following experiments indicate, however, that the roughening is caused by a deposit of silica on the glaze and not by a destruction of the glaze by the action of the solution.

The Argillaceous Limestone, sent out about a year ago by the Committee on Uniformity in Technical Analysis, was used in this work. In the first part of the work the limestone was decomposed by first blasting a weighed portion, then dissolving as much as possible in hydrochloric acid, filtering, igniting the residue, fusing it with sodium carbonate, and adding the melt to the original solution. Later the weighed limestone was mixed at once with about a-half grm. of sodium carbonate and fused. The melt was then treated with water and finally acidified with hydrochloric acid. The method of decomposition apparently had no effect on the silica determination, and the second method is much more convenient.

The solution obtained as above was evaporated as dry as possible on the steam bath. The residue was moistened with 10 cc. of concentrated hydrochloric acid, 50 to 100 cc., (depending on the size of the dish) of water was added, and it was digested on the steam bath for ten minutes. The silica was then filtered off and washed thoroughly. The filtrate and wash water were evaporated and treated as above. The filtrate from the second evaporation was made alkaline with ammonium hydroxide and the precipitate filtered out. In the first two determinations this precipitate was ignited and then fused with acid potassium sulphate, dissolved in dilute sulphuric acid, evaporated to white fumes, diluted with water, and the silica separated by filtration. In the rest of the work the precipitate formed by the ammonium hydroxide was collected and washed on a filter, dissolved at once in dilute sulphuric acid, and the ash of the dried and burned filter added. The solution was then evaporated to white fumes, diluted with water, and the silica separated by filtration.

The silica from the two evaporations was placed in a platinum crucible, the carbon of the filter burned, and the silica was then ignited over the blast for ten minutes, cooled, and weighed. The silica from the ammonium hydroxide precipitate was treated in the same way, and the per cent of silica was calculated from the total.

A few determinations of the silica were made with platinum dishes in order to determine the per cent of silica in the limestone. The other evaporations were made in porcelain dishes varying from 9½ to 15 cm. in diameter, some of which were set as low as possible in the steam, others so that only a small part of the bottom of the dish was in direct contact with the steam. Some of the dishes were covered quite closely with Victor Meyer funnels, others were left entirely open. In some cases new dishes were used, and in others dishes were used which had been used several times before and then thoroughly cleansed. None of these conditions apparently affected the results.

In the report of the Committee on Uniformity in Technical Analysis (*Journ. Am. Chem. Soc.*, xxviii., 229), Dr. Hillebrand gives the per cent of silica in this limestone as 18·11 and Dr. Waters gives it as 18·18. Five determinations which I made gave 17·93, 18·10, 18·11, 18·05, 18·01, or an average of 18·04 per cent. (In the first of these determinations the bottom of the platinum dish was a little rough and this *might* have caused a slight loss).

In the first determination in porcelain there was a heavy rough deposit left as a ring part way up the side of the dish, which could not be removed by rubbing with a "policeman," and the per cent of silica was found to be 17·09. The dish was then filled above this roughness with water containing ammonium hydroxide and heated on the steam bath for some time. (All of the ammonium hydroxide used in this work was freshly distilled and tested for silica). The solution was then acidified with hydrochloric acid, evaporated to dryness, taken up in water and hydrochloric acid, and filtered, A second treatment of the same kind left the dish bright and smooth, and the silica thus separated amounted to 0·88 per cent of the limestone, so that the total silica then amounted to 17·97 per cent, in very good agreement with that found in platinum. In another case the per cent of silica was found to be 17·58 and 0·38 was separated from the dish by the ammonium hydroxide treatment. In the other determinations only a faint stain was noted on the dish and the treatment with ammonium hydroxide was omitted.

The following results in per cent of silica were obtained, using porcelain evaporators (17·09+0·88), 17·71,

* I cannot agree with Professor Morse in this, for if the dish is rinsed with hot water it dries almost at once, and then particles of silica are easily seen on the shiny porcelain surface.

17·87, 17·77 (17·58+0·38), 17·81, 17·88, 17·96, 18·04, 18·07, 18·01, 17·98.

These results show that silica is not obtained from the dish when porcelain evaporators are used, but that there is usually a slight loss of silica from a portion adhering to the dish, and that occasionally this loss may be so great as to seriously affect the accuracy of the determination even for technical purposes. This silica adheres so tenaciously to the dish that it cannot be removed by ordinary means, but can be removed by heating with ammonium hydroxide.

Up to the present I have not been able to discover the conditions which cause the adherence of the larger amounts of silica, but I am convinced that the two cases quoted here are not isolated instances, but that similar cases will be found frequently.

These results show that, although platinum dishes are always to be preferred for the evaporation in silica determinations, porcelain dishes may be used satisfactorily for technical analyses if the dry dish is carefully examined after each analysis and no more than a slight stain is noted on the glaze. If a dull or rough surface, usually as a ring part way up on the side of the dish, is found, it must be removed and its silica added to the other, or the determination must be repeated.—*Chemical Engineer*, v., No. 1,

THE DETECTION OF BARIUM, STRONTIUM, AND CALCIUM.

By STANLEY R. BENEDICT.

THE distinctive features of the following method for the detection of the alkaline earth metals may be briefly summarised as follows:—1. In contradistinction to most, if not all other, methods, it provides for the removal of barium without the use of chromate or dichromate, thus giving colourless solutions for the subsequent detection of strontium and calcium. 2. It entirely avoids the somewhat troublesome operation of filtering solutions containing the precipitated sulphates of calcium, barium, or strontium. 3. The method is very rapid, the manipulation simple, and the results positive. The precipitates dealt with filter perfectly clear without difficulty.

The reagents used are saturated potassium iodate solution, dilute hydrochloric acid, ammonium oxalate, and saturated ammonium sulphate solution.

As preliminary to an outline of the method, it may be well to mention the following facts, upon which it is based:—

Barium iodate, while somewhat soluble in water, is practically insoluble in an excess of potassium iodate solution of proper concentration, even in the presence of a certain amount of hydrochloric acid. Barium is therefore completely precipitated from its solutions by an excess of potassium iodate, in presence or absence of dilute hydrochloric acid, the filtrate yielding absolutely no turbidity with sulphate or chromate solutions.

Strontium iodate is more soluble in water than is the corresponding barium compound. Like the barium salt it is completely precipitated from neutral or slightly ammoniacal solutions upon addition of a considerable amount of iodate solution, the precipitation taking place somewhat more slowly than with the barium compound. Unlike the barium salt, however, strontium iodate is quite soluble in dilute hydrochloric acid, and strontium is therefore only incompletely, if at all, precipitated by an iodate from its solutions which have been acidified with dilute hydrochloric acid.

Calcium iodate is more soluble than either the barium or strontium compound, and is only incompletely, if at all, precipitated from neutral, acid, or ammoniacal solutions, upon addition of an excess of iodate solution.

The precipitated iodates of all these metals form bulky, granular precipitates which filter clear very rapidly.

An outline for the procedure for the identification of calcium, strontium, and barium follows.

A portion (2 to 3 cc.) of the solution to be tested is acidified with one-half its volume of 5N hydrochloric acid, and to the liquid thus obtained its own volume of a saturated solution of potassium iodate is added. If a precipitate forms *at once*, barium is present. If no precipitate forms, barium is absent. If a precipitate forms slowly, either barium is present in low concentration or strontium is present in considerable amount. In such a case the presence or absence of barium should be confirmed by the addition of a few drops of dichromate solution to the original solution. This confirmation is rarely necessary.

Having established the presence or absence of barium, the solution is agitated and allowed to stand for one-quarter to one-half a minute. The precipitate is filtered off, and to a portion of the filtrate (not the first portion through the filter) is added a little more than an equal volume of a saturated solution of ammonium sulphate. The solution is then heated to boiling. A white precipitate, permanent on boiling, consists of strontium sulphate, and indicates strontium.

To another portion of the original solution is added two volumes of a saturated potassium iodate solution, the mixture agitated, and allowed to stand one-half to one minute, and filtered. To the filtrate is added some ammonium oxalate solution (one-half volume of the ordinary reagent). The solution is now warmed to boiling. The formation of a white precipitate (consisting of calcium oxalate), either in the cold or upon warming, indicates calcium.

The directions given above apply to neutral or faintly ammoniacal solutions of the chlorides of calcium, strontium, and barium. In the ordinary course of a qualitative analysis the precipitated carbonates should be dissolved in a little hydrochloric acid, and the resulting solution evaporated to dryness, warming gently to expel free acid. The residue from this evaporation should be dissolved in 6 to 10 cc. of water, and this solution used for the analysis. The portion to be tested for calcium may be treated with a drop of ammonium hydroxide solution to insure the absence of free acid.

In the use of the above method, particular attention should be given to the following points:—The potassium iodate solution used as a reagent must be fully saturated. This reagent is conveniently prepared by using enough of the dry salt to make a N/2 solution, and allowing it to stand some hours, with occasional shaking. If it is desired to dissolve the salt more quickly by heating to boiling, the warm solution must be cooled to ordinary temperature and agitated before use.

In adding the reagents, particularly the iodate and hydrochloric acid solutions, the amounts added must correspond quite closely with what is called for in the directions given above. The adequacy of these directions has been tested by their employment in analyses of some forty mixtures by myself and others, in the laboratory of the University of Cincinnati. The results obtained were entirely correct.

I desire to express my sincere thanks to Dr. J. F. Snell, whose continued encouragement and suggestions have been invaluable, in this, as in my previously published work.—*Journal of the American Chemical Society*, xxviii., No. 11.

NOTICES OF BOOKS.

Practical Physical Chemistry. By ALEX. FINDLAY, M.A., Ph.D., D.Sc. London, New York, and Bombay: Longmans, Green, and Co. 1906.

A FAIRLY elementary text-book of practical physical chemistry has for seme time been much wanted, and the author of the "Phase Rule and its Applications" has already given proof of his special qualifications for making the subject interesting and clear. This book quite bears out his high reputation, and will be of the greatest value to

the advanced student. Experimental details are fully described, and as the different chapters are as far as possible independent one of the other, the teacher can quite easily re-arrange the course if it seems desirable to him, and by the time the pupil has worked through the he will have laid a firm foundation in physical chemistry, and will have a much better grasp of the subject than if he had relied upon book knowledge only. The book begins with a chapter of notes on the calculation of results and errors, in reference to which we may point out that the inversion method in contracted multiplication is not generally found the easiest for the student to manipulate with success. In the next chapters on the densities of liquids and gases, the definition of density might with advantage be amended in a subsequent edition. Viscosity, optical measurements, and the distribution law are then considered, when an interesting and instructive series of experiments is described. Electrical methods, conductivity determinations, &c., are treated very fully, and the book as a whole forms an admirable supplement to lecture-work on physical chemistry.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Comptes Rendus Hebdomadaires des Séances de l'Academié des Sciences. Vol. cxliii., No. 25, December 17, 1906.

Report on the Work of M. Grignard (Winner of the Jecker Prize for 1906).—By Henri Moissan.

In 1898, Ph. Barbier was the first to point out that in certain cases magnesium could be advantageously substituted for zinc in Saytzeff's reaction. He thus accomplished the synthesis of dimethylheptenol by treating methyl iodide with natural methylheptenone in presence of magnesium filings. Two years later, M. Grignard resumed the study of this question on the advice of M. Barbier, and he soon discovered that magnesium affords a far greater facility of reaction than zinc, but that in Saytzeff's method it more often furnished numerous products of polymerisation. M. Grignard then had recourse to Wagner's plan of preparing the organo-magnesium compound, not by the methods of Löhr, Fleck, and Waga, which experiment had condemned, but by utilising a process already tried by Frankland and Wanklyn for the the organo-zinc combinations. These scientists had observed that in heating methyl iodide with zinc filings in presence of anhydrous ether a volatile product was obtained soluble in ether, possessing the properties of zinc methyl, and apparently corresponding to the formula $Zn(CH_3)_2+O(C_2H_5)_2$. Only the difficulty of conveniently isolating this compound rendered their method inapplicable.

It was to be expected that a metal like magnesium, more electro-positive than zinc and possessing more active affinities, would react more completely and readily; and this result was in fact obtained, for experiment showed that magnesium in presence of an anhydrous ether oxide, and particularly ethyl oxide, attacks the greater number of the halogen ethers even at the ordinary temperature, and furnishes in a total reaction a product soluble in ether.

These organo-magnesium combinations correspond to the general formula RMgX, in which X represents a halogen, and R a monovalent organic radical, fatty, aromatic, polymethylenic, or terpenic. Frequently the presence in this radical of another functional group does not hinder the reaction from being normal. This fact has been established already for the ether oxides of the alcohols (Hamonet), and of the phenols (Bodroux), for α-monobromcamphor (Brühl, Malmgren), iodo-1-hexanone-5 (Zelinski and Moser), for the halogen derivatives of the tri-substituted aromatic amines (Ehrlich and Sachs), and also the mono-substituted (A. Baeyer).

However, the presence of a double bond in the neighbourhood of the halogen atom may render the reaction abnormal, which happens in the case of the bromide and iodide of allyl (Grignard).

Speaking generally, it is the bromine and iodine derivatives which react the most readily; the primary derivatives react better than the secondary and much better than the tertiary (Grignard, Bouveault).

The mixed organo-magnesium compounds are always associated with one or even two molecules of ether (Tschelinzeff). They should probably be regarded as derivatives of oxonium of formula—

$$\begin{matrix} C_2H_5 \\ C_2H_5 \end{matrix}\!\!>\!O\!<\!\begin{matrix} MgR \\ X \end{matrix} \quad \text{or} \quad \begin{matrix} C_2H_5 \\ C_2H_5 \end{matrix}\!\!>\!O\!<\!\begin{matrix} MgX \\ R \end{matrix}$$

(A. Baeyer and Villiger). (Grignard).

They may be obtained free from ether in a neutral solvent by employing ether or a tertiary amine as catalyser, but in that case they are insoluble.

The ether-organo-magnesium combinations are distinguished by a remarkable facility of reaction. This facility has led to their being substituted in almost all cases (except for the synthesis of allyl alcohols) for the organo-zinc compounds, with great advantage from the point of view of rapidity, and yield a number of the reactions. These compounds have also enabled the institution of a certain number of new methods for which the zinc compounds are altogether inapplicable.

Altogether about 350 memoranda of the organo-magnesium compounds and their applications have been published. The most important will be mentioned, with a survey of their principal properties.

All the compounds which possess a movable hydrogen atom, water, acetylene carbides, alcohols, phenols, acids, ammonias, amines, amides, imides, electro-negative compounds with the group CH_2, &c., exchange this hydrogen atom with the MgX derivative with the formation of a hydrocarbide, RH (Grignard and Tissier, Mermier, Houben, &c.). In particular, the true acetylene compounds, $R'.C\equiv CMgX$, possess all the properties of the other organo-magnesium products (Jotsitch).

It is to the synthesis of alcohols that the new organo-metallic compounds have most richly contributed. Oxygen oxidises them into alcohols or phenols (Bodroux, Bouveault, Zelinski). The aldehydes, ketones, ether-salts, chlorides, and anhydrides of acids lead generally with good returns to primary, secondary, or tertiary alcohols, as the case may be (Grignard, Grignard and Tissier).

The methods of synthesis of the aldehydes have been largely revised; we may quote the use of the formic ethers at −50° (Gattermann and Maffezoli), of ethyl orthoformiate (Tschitschibabin, Bodroux, Moureu, and Delange), of the di-substituted formamides (Bouveault), and of the carbylamines (Sachs and Levy), as well as the indirect products of MM. Béhal and Sommelet connected with certain ether-oxides of α-glycols.

The case is the same for the synthesis of ketones by the action of the nitriles (Blaise), the imides (Béis), the anhydrides of acids at −20° (Fournier).

We may add that the presence in the same molecule, of several replaceable functional groups does not, in general, hinder the reactions from proceeding normally, either simultaneously if all the groups are identical, or successively if the groups are not equally electro-negative. Thus, the diketones, except the β-diketones (Valeur, Zelinski), the ethers of dibasic acids (Valeur), give, in general, bi-tertiary glycols, the aldehydic or ketonic alcohols give glycols (Tiffeneau, Franke and Cohn); the ketone ethers, except the β, the chloride of ethyloxalyl, give rise to the alcohol acids (Grignard), and cyanacetic ether to the β-ketonic ethers (Blaise).

The direct fixation of the carbonic anhydride upon the magnesium derivative furnishes a method of synthesis of acids often preferable to the employment of potassium cyanide (Grignard, Houben and Kesselkaul, Zelinski, Jotsitch).

It is worthy of note that these organo-magnesium compounds possess the property of uniting with the double bonds of the aromatic ketones to give rise to substituted saturated compounds (Kohler, A. Haller and E. Bauer).

Finally the organo-magnesium compounds can combine with halogen organic bodies, producing by elimination of the mineral part, either hydrocarbons (Houben, Tiffeneau), or more complex compounds (Hamonet, Grignard). The action of ethylene monochlorhydrin, in particular, has enabled the carrying out of the only regular method of synthesis of the primary arylethyl alcohols (Grignard).

An analogous process with the halogen derivatives of the metals or metalloids has furnished a whole series of organo-metallic compouuds of tin (Pope and Peachey), antimony, lead, mercury (Pfeiffer and his pupils) thallium (Meyer and Bertheim), silicon (Kipping, Dilthey and Eduardoff), phosphorus and arsenic (Auger and de Billy, Sauvage).

To complete the account, mention must be made of many interesting researches upon iodine, sulphur, selenium, sulphurous anhydride, carbon sulphide and oxysulphide, phosgene, the quinones, the ketone ethers of active alcohols, the magnesium derivatives of alcohols, amines, &c.

These numerous examples abundantly testify to the value and fertility of the reaction that chemists have, with justice, called the *Grignard reaction*.

Lavoisier Medal.—Report of M. Berthelot.

This medal is awarded by the Bureau de l'Académie to S. M. Jörgensen.

The first researches of S. M. Jörgensen on the periodides of the alkaloids were published in 1867. These experiments led him to the discovery of a tri-iodide of potassium, then of a hexaiodide of mercury, and finally of the double periodides of thallium and of the ammoniated and phosphuretted bases.

Since then, he has devoted himself entirely to the study of the ammonium metallic bases.

Continuing and extending the researches of Frémy and Blomstrand, he carried on his investigations successively upon the series of the yellow, pink, and purple salts of cobalt, chromium, and rhodium. He demonstrated how these could be recognised and how one could pass from one series to the other. These researches were completed later by the cryoscopic investigations of M. Petersen.

To these important series there have been added researches upon the xanthochromic salts, rhodosochromic salts, platinic acid and its curious compounds.

For the importance of his results, S. M. Jörgensen certainly takes the first place in this special branch of chemistry, the ammonium metallic bases, to which so many chemists have turned their attention. He has co-ordinated and classified all the series, or nearly so, for the trivalent metals. In the latter years he has brought much matter to the difficult study of the platinum bases.

The purity of the purple salts of rhodium has enabled him to prepare this metal under quite new conditions, and to determine thence its atomic weight.

MEETINGS FOR THE WEEK.

MONDAY, 7th.—Society of Chemical Industry, 8. "Sixth International Congress of Applied Chemistry at Rome," by W. F. Reid.

TUESDAY, 8th.—Royal Institution, 3. (Christmas Lectures, adapted to a Juvenile Auditory). "Signalling to a Distance, from Primitive Man to Radio-telegraphy" (Experimentally Illustrated), by W. Duddell, M.Inst. E.E.

WEDNESDAY, 9th.—Society of Arts, 5. (Juvenile Lecture). "Perils and Adventures Underground," by Bennett H. Brough.

GOVERNMENT GRANT to defray the expenses of Scientific Investigations. Applications for the year 1907 must be received at the Offices of the Royal Society not later than JANUARY 31st next, and must be made upon printed forms to be obtained from the Clerk to the Government Grant Committee, Royal Society, Burlington House, London, W.

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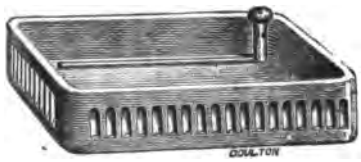

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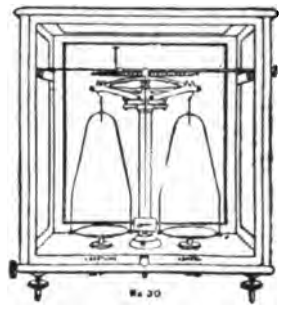

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CALCIUM AS AN ABSORBENT OF GASES FOR THE PRODUCTION OF HIGH VACUA AND SPECTROSCOPIC RESEARCH.*

By FREDERICK SODDY, M.A., Lecturer in Physical Chemistry in the University of Glasgow.

I. *Introductory.*

THIS paper contains an account of researches carried out by the aid of an electric furnace designed to heat reagents in soft glass tubes up to temperatures far above the softening point of glass, and has special reference to the use of calcium under these conditions as a valuable absorbent of gases. Recent work on the generation of helium from the radio-elements has shown the necessity for more simple, certain, and powerful means of absorbing other gases and in particular nitrogen. The usual practice of Sir W. Ramsay and the writer when working together was to make provision for the removal of compounds of hydrogen, oxygen, and carbon, but to take the utmost precautions against the admission of air into the apparatus in the first place. If nitrogen was present in spite of the precautions taken, it was often possible, by gently running the spectrum-tube, to absorb it by the hot electrodes of aluminium, the lines of helium, if present, appearing as the nitrogen spectrum faded.

The difficulty in absorbing nitrogen is that the usual absorbents, for example, a mixture of lime and magnesium, only react above the softening temperature of an exhausted soft glass tube, and the present researches had their origin in an attempt to enable higher temperatures and more powerful absorbents of gases to be used within soft glass apparatus. Lithium, it is true, absorbs nitrogen at a very low temperature, but its use introduces hydrogen. A good example of a very perfect train of absorbents, able to absorb all known gases with the exception of those of the argon family, is to be found in the recent researches of Debierne on the production of helium from radium and actinium (*Comptes Rendus*, 1905, cxli., p. 383). "Oxygen is absorbed by heated copper; the absorption of hydrogen is secured by the action of heated copper oxide and phosphorus pentoxide, at the same time the copper oxide transforms gaseous carbon compounds into carbon dioxide, which is absorbed by potash, and finally nitrogen is absorbed by pure lithium."

Now such an apparatus serves but one experiment, and has to be built up afresh for each, because it is necessary to fill it after the absorption with mercury in order to compress the helium sufficiently to detect it. The labour involved during a lengthy investigation may be imagined. It is therefore very satisfactory to be able to state that I have found that a single reagent, namely, calcium, at the high temperature attainable by the use of my furnace, would serve instead of all the reagents employed by Debierne, and do the work far more effectively and rapidly. Calcium, under the conditions mentioned, is a universal absorbent of all gases with the exception of the argon group.

II. *Historical.*

Till recently calcium has been a very uncommon metal, while barium and strontium still belong to the category of chemical curiosities. Maquenne (*Comptes Rendus*, 1892, cxiv., p. 225), found that when amalgams of these three metals were heated in nitrogen, the mercury was volatilised and nitrides of the metals were formed. The absorption took place at a lower temperature than in the case of the metals magnesium and aluminium. Barium was stated to lend itself best to the experiment. None of the alkaline-earth metals were investigated by Lord Rayleigh and Sir W. Ramsay in their examination of the known absorbents of nitrogen (*Phil. Trans.*, 1895, clxxxvi., A, p. 187) on account of the difficulties in obtaining large quantities of these metals at that time. After the discovery of argon, Maquenne (*Comptes Rendus*, 1895, cxxi., p. 1147) showed that a mixture of calcium oxide and magnesium rapidly absorbed the oxygen and nitrogen of the air when heated in a hard glass tube, and attributed this reaction to the production of calcium in an extremely divided state. He states that a monometer attached to the apparatus showed a diminution of pressure from the atmospheric equal to 70 and even 73 cm. of mercury. This mixture is now commonly employed in the preparation of argon, and it is customary to accept Maquenne's explanation of its absorbing power. It is, however, quite certain that the commercial calcium in the form of compact metal bars, produced by electrolysis, behaves in a manner entirely different from the "nascent calcium," if such it be, produced by heating a magnesium and lime mixture; for the former, heated in a tube filled with air at atmospheric pressure, produces no noticeable absorption, even at the highest temperatures.

Moissan first succeeded in preparing calcium in quantity sufficient to make an accurate study of its proportion (*Comptes Rendus*, 1898, cxxvi., p. 1757, and cxxvii., pp. 29, 497, and 584). His calcium was in finely divided crystalline condition, and was obtained by acting upon calcium iodide with excess of sodium. The calcium is deposited out from the sodium on solidification, and the latter is removed by the action of absolute alcohol, which does not attack calcium. He showed that at a dull red heat this calcium absorbs both hydrogen and nitrogen with incandescence, forming nitride and hydride respectively. The hydride heated to the softening temperature of a Bohemian glass tube in an atmosphere of hydrogen neither absorbed nor evolved gas. In a determination of its melting-point the calcium was heated in a vacuum obtained by the use of a mercury pump. Moissan noted the evolution of small quantities of gas which were pumped off, "but as soon as the metal became dull red hot the last traces of gas are absorbed, and the vacuum stood at 1 mm." This inconsistency might have been due to sticktion of the mercury in the guage, or to an error in its reading, for, as Moissan himself remarks, the last traces of gas are absorbed under these conditions.

Calcium, electrolytically produced in the form of compact bars, free from mercury and oil, has been available for over two years, and has been the subject of much interest. Those who have examined it must have been more struck with its apparent disinclination to react than with any exceptional reactivity. Thus the attempts to replace the magnesium or magnesium-lime mixture by this calcium in the preparation of argon have never succeeded in my experience. Even when heated to 1200° C. in an electric oven it refuses, after a very slight initial action, to absorb nitrogen. It must be heated to a very high temperature in the blowpipe before it ignites in the air, and then readily goes out. In one experiment a powerful arc was caused to pass between calcium points in air without inducing combustion.* Negative results of this character could be multiplied.

Arndt undertook a research on the melting-point of commercial calcium (*Ber.*, 1904, xxxvii., p. 4733), in which the

* Read before the Royal Society, November 15th, 1906. (An abstract of this Paper appeared in CHEMICAL NEWS, vol. xciv., p. 305).

* This, however, is partly due to the extraordinarily slight heating which electrodes of calcium experience when a discharge is passed through a gas between them. Of all metals calcium heats the least, and is in this respect far superior to aluminium. But for other difficulties it might be used to replace aluminium, with advantage, as the electrodes of vacuum tubes in the case of the inert gases. A steady arc can be maintained between calcium points in air with a very small ampèrage.

metal was heated as in Moissan's experiment in a vacuum of 1 mm. pressure to avoid chemical action. He noticed that the calcium began to volatilise below its melting-point, and that the vapour reacted energetically with the residual air, so that the pressure on the manometer sank to an unreadable value. Absorption commenced at 700° C., was rapid and accompanied by visible volatilisation at 730°, whereas the melting-point was found to be 800°. When a Plücker spectrum tube was included, it was found that "the nitrogen spectrum faded rapidly, while the lines of hydrogen (from a trace of water present) remained behind with the lines of argon." He found that the vapour of magnesium did not exhibit nearly the absorptive power of calcium.

With the use of the apparatus to be described I arrived independently at, and have confirmed, the observation of Arndt on the extreme rapidity of absorption of the oxygen and nitrogen of air by the vapour of calcium. In addition I have found that all the common gases can be absorbed equally well, although in some cases, as the above quotation from Arndt's paper shows for hydrogen, complete absorption is not effected by simple heating alone.

III. *Electric Furnace for strongly Heating Reagents in Glass Vessels.*

The apparatus usually employed depends upon the internal heating of the reagent by an electric resistance circuit and the protection of the glass walls by a screen of porcelain placed between it and the enclosed furnace. It is shown to the scale of 6 inches to the foot in section in Fig. 1. Figs. 2, 3, 4 are transverse sections on the lines x, y, z respectively. The outer containing vessel is made out of soft glass tubing, and is in two parts, the upper B and the lower B_2, which are ground to fit together accurately at D. The lower part B_2 has two mercury cups with platinum wires b_2 sealed through the glass. The upper part B widens at the shoulder d, on which rests the porcelain shield-tube K. This is slipped into the tube, which is then constricted at A and joined to a narrow piece of tubing for connecting to other apparatus. The furnace tube J, which carries the heating wire, slides through the ground-joint of B and passes inside the shield-tube K. For the upper part of its length it is grooved with an external screw thread of about 1 mm. pitch, and wound with a platinum wire *ii* of 0·25 mm. diameter. It passes through the holes *jj* into the inside of the tube, and is joined to stouter leads of nickel, copper, or platinum, or is simply doubled on itself. The leads pass through the doubly-bored porcelain insulator I, which slips within the lower half of the furnace tube and the upper part of B_2, and are finally taken into the mercury cups. The lower end of the furnace-tube J rests on, and is supported by, the upper end of B_2, and itself surrounds and supports at its upper end a porcelain test-tube L, in which the reagent to be heated is placed at C.

The whole arrangement is readily taken to pieces at the ground-joint D, for re-charging, cleaning, or repairs. The end B_2 usually carries between the two mercury cups a narrow tube, shown by dotted lines, to which is attached a bulb and tap, shown in Fig. 5, for the purpose of admitting mercury into the apparatus without introducing air, and also for conveniently filling the mercury cups and other purposes. An oil or mercury seal may surround the ground-joint, but it is not necessary if it is of good workmanship.

For special work, where the possibility of leaks or the the presence of vapour of grease is to be avoided, it is easy to dispense with the ground-joint D and to make the apparatus in one piece. In this case B is made long so that it can be repeatedly opened and sealed, and the various parts are introduced through the upper end by suitable tongs. But these refinements are usually quite unnecessary if the ground-joint is of good workmanship and is well lubricated, and if the leads are of sufficient conductivity not to heat the joint. In special work, too, the mercury cups may be dispensed with and the wires continued through the glass seal if the presence of mercury vapour is to be avoided.

[*Added*, Nov. 20.—An improved and thoroughly satisfactory method of working, applicable whether the ground-joint is used or not, is to dispense with the porcelain insulator I, and to bore two holes opposite each other at the lower end of the furnace tube J, twisting one end of the doubled platinum heating wire through each hole together with a length of "flexible" copper wire, and continuing the two

Fig. 1.

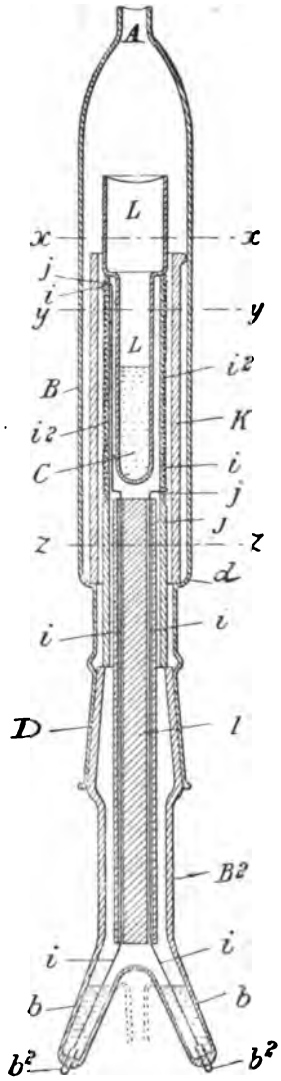

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Fig. 2

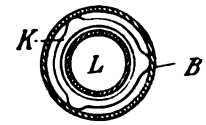


Fig. 3.

Fig. 4.

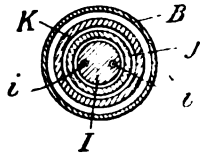
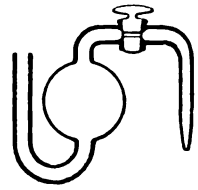


Fig. 5.



flexibles, insulated if necessary in little glass tubes, into the cups *bb*, where they make good touching contact with the platinum, without the use of mercury. In this way a mechanically strong joint with the fine heating wire is secured, the presence of mercury inside the vacuum is altogether avoided, and the formation prevented of a mercury arc between the two cups when a high tension discharge is passed through the vacuum, which in the first form of apparatus constituted an occasional source of annoyance and damage.]

With this apparatus reagents may be safely heated to temperatures far above the melting-point of glass without injuring the apparatus. After nearly two years' use of these furnaces I do not recall a single case where the heat has caused the glass to crack or break while in use, although, of course, the glass tends to get brittle and to break when being cleaned more readily after use than before. If required for prolonged heating at high temperature it is an advantage to blow a bulb on the tube at the hottest part of the furnace, otherwise, when the porcelain shield-tube has become heated through, the glass is apt to melt. These shield-tubes never break. The furnace-tubes are more fragile but stand extremely well, while, of course, the test-tubes containing the reagents require the most frequent replacement. Tubes made of thin iron would for many purposes have very many advantages over porcelain. But they must be gas-tight at the lower end, for the vapour of calcium would ruin the platinum wire if it came in contact with it.

The limit of temperature attainable in this apparatus is fixed mainly by the volatility of the heating wire in the high vacuum usually maintained within the apparatus, and for this reason platinum or one of its alloys must be used. Iron or nickel volatilise and the wire is destroyed in a few minutes. Even with platinum the volatilisation of the metal is serious at a bright-red heat. In addition, a certain tendency to become brittle with loss of metallic qualities, which is noticeable in ordinary platinum resistance furnaces, thermometers, and thermocouples, and which prevents their prolonged use at temperatures above 1200° C., appears to be far more marked and to take place at lower temperatures in the high vacuum, rendering occasional re-windings of the furnace necessary. The cause of this has not been fully explained. An examination of somewhat analogous phenomena in the case of nickel has been recently made by Dr. H. C. H. Carpenter in a paper read before Section G of the British Association, 1906, and attributed by him to gases in the nickel (*Engineering*, August 17, 1906, p. 222). I am inclined to connect the phenomenon in the case of platinum with the vaporisation of the metal. If tantalum wire could be obtained, no doubt it would prove far more suitable than platinum. Naturally, a high vacuum within the apparatus tends greatly to conserve the heat and to diminish convection, and the risk of the outer vessel melting. In this respect the apparatus is the antithesis of the Dewar vessel for storing liquid air.

IV. *Absorption of Gases by Calcium.*

If the apparatus described, charged with a small piece of calcium, and furnished with a Plücker spectrum-tube, is exhausted by a Fleuss pump, and the furnace heated, gases, consisting of compounds of hydrogen, carbon, and oxygen, are given out by the calcium. If connection with the pump is then shut off and the heating continued, absorption of the remaining gases, accompanied by volatilisation of the calcium, takes place, and the vacuum rises almost instantly to a point at which no discharge can be passed through the spectrum-tube. By a non-conducting vacuum is to be understood one of greater resistance than an alternative spark gap in air of 2 to 3 cm., unless the length of the gap is given.

If air is introduced into the apparatus, all but argon is rapidly absorbed, and quantities up to 10 or 20 cc. can be thus dealt with. These experiments with air are, however, of interest from so many points of view that they will be dealt with in detail later.

In a similar way it was shown that carbon monoxide, carbon dioxide, water vapour, hydrogen, acetylene, sulphur dioxide, ammonia, and the oxides of nitrogen (nitric oxide, with deflagration of the calcium) are all as readily and completely absorbed as in the case of the oxygen and nitrogen of the air. Quantities of the several cubic centimetres disappear within a minute after introduction, and the vacuum-tube becomes non-conducting.

Finally, in order to put the power of the calcium to as severe a test as possible, several successive quantities of coal-gas, each of several cubic centimetres, were introduced into the apparatus after the absorption temperature had been attained. Within a minute after each addition the spectrum-tube became non-conducting to the discharge. Calcium thus acts as a universal absorber of chemically valent gases.

The case of hydrogen and its compounds alone calls for fuller treatment, for at too high temperature calcium hydride possesses an appreciable tension of dissociation. The same is of course true of calcium carbonate, but this compound does not appear to be formed when only small amounts of carbon dioxide are absorbed by the calcium. If hydrogen or its compounds are present in a gas in large quantity, the spectrum-tube, after the absorption of the other gases, shows still the hydrogen lines, and refuses to become non-conducting as long as the temperature of the furnace is maintained. But if the heat is reduced the non-conducting stage is reached at once. In one experiment 1 cc. of hydrogen was introduced, and the heat reduced. The spectrum-tube became non-conducting in forty seconds.

Careful experiments have shown that even after cooling an infinitesimal quantity of hydrogen remains unabsorbed. Thus if, after cooling, mercury is allowed to fill the apparatus and compress the residual gas many hundred times into a tiny spectrum-tube, a very faint hydrogen spectrum can be seen, although the spectrum-tube, even after this concentration of the gas, is still of high resistance and fluoresces brilliantly under the discharge. This residual trace will be shown to be of great value in certain experiments.

A point of very great practical importance arises out of the dissociation phenomena of calcium hydride. Different commercial specimens of electrolytic calcium exhibit differences in their behaviour which I have traced to the presence of hydride in some specimens and not in others. The presence of this hydride quite alters the characteristics of the absorption process, and although with sufficient experience it is possible to get good results in spite of the presence of hydride, this experience is apt to be dearly bought. When hydrogen is present the real absorption temperature is apt to be overstepped, for instead of a non-conducting vacuum being obtained, as it should be almost instantly with a proper specimen of metal, the dissociation tension of the hydrogen is sufficient to enable the discharge to pass. An inexperienced operator or one accustomed only to the character of the purer metal, will, in consequence, continually increase the temperature, and the tension of the hydrogen of course increases, and may ultimately become quite measurable on a guage. Before it is realised that the proper temperature has been far overstepped, the metal may have melted, subsequently to crack the crucible on cooling, the platinum wire may fuse or volatilise, and even the glass envelope may soften. Whereas, if instead of increasing the temperature, the heat had been cut off, the non-conducting stage would have been reached in a few seconds. It was noticeable that of two specimens, one excellent and the other containing hydrogen and unsuitable, the latter was by far the more malleable and could be always detected by this test after it had accidentally got mixed with the other specimen. But this difference of properties may not have been due to the presence of the hydride. No one would use metal containing hydride wittingly, but it is well to know that by cutting off the heat, when the spectrum of the gas becomes that of hydrogen, quite satisfactory results are attainable. But the sacrifice of time and apparatus, destroyed by excessive temperature, was considerable before the differences between the specimens of metal were suspected and the differences of behaviour understood.

Experiments were tried to see if calcium which had been strongly heated and allowed to cool in an atmosphere of helium and argon, respectively, re-evolved any trace of these gases when re-heated *in vacuo*, but in each case with negative results.

(To be continued).

AN EXAMINATION OF THE LIGHTER CONSTITUENTS OF AIR.*

By JOSEPH EDWARD COATES, B.Sc. (Wales).

This research was undertaken with the object of ascertaining whether a large quantity of air, if systematically fractionated, would yield any constituent lighter than helium. It has been stated that "coronium" has revealed its presence in the gases emitted from the Solfatara of Pozzuoli by a line of wave-length 531·5—531·6; and that from some of the Vesuvian fumaroles gases have been obtained which give rise to new lines not coincident with any important lines in the neon or helium spectra (Nasini, Anderlini, and Salvadori, *Accad. dei Lincei*, 1898, vii., p. 73). Again, it has been stated in a lecture delivered at the Royal Institution (April 11, 1902), that the most volatile part of the atmosphere contains constituents showing many unknown lines (Dewar). Since that date, however, no further account of such substances has appeared.

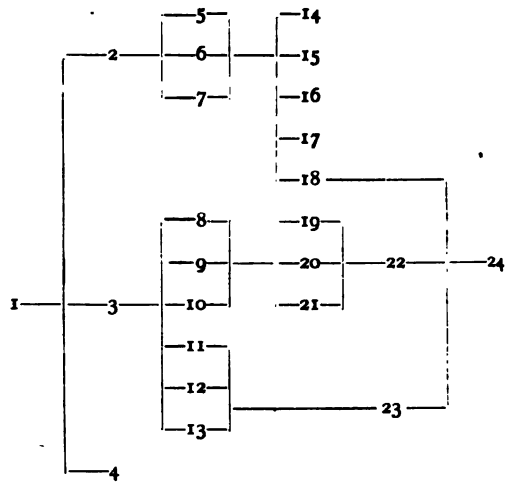
Another object of the present research was to determine the proportion of free hydrogen in air by the method of fractionation. The most important estimations have been made by Gautier, Rayleigh, and Dewar. Gautier, using the method of passing air over red-hot copper oxide, found 19·5 volumes of free hydrogen in 100,000 volumes of air, *i.e.*, about half as much free hydrogen as carbon dioxide (*Ann. Chim. Phys.*, 1901, xxii.). Rayleigh (*Phil. Mag.*, 1902, iii., p. 416) discussed, and, in part, repeated the work of Gautier; he considered three parts per 100,000 as a maximum estimate, but regarded the question as still unsettled. Dewar, in the lecture mentioned above, stated that 100,000 parts of air contain not more than one part of hydrogen.

The conclusions arrived at in this paper may be briefly stated:—(1) There are no unknown lines in the spectrum of the lightest portions of the air, all those observed being traceable to helium, neon, and hydrogen; (2) the amount of hydrogen separable from air is much less than that given by the above-mentioned investigators, for it amounts to about one volume per million and a-half volumes of air.

The first stage in the fractionation was effected by means of the air-liquefying apparatus at University College, Gower Street. The air of the compressor room (situated in the basement and well ventilated) passed through the apparatus, and the portion which did not liquefy was collected in a large gas-holder. This, together with fresh supplies of air, was repeatedly circulated through the apparatus, with the object of making a preliminary concentration of the lighter portions. To avoid contamination with hydrogen, the gas-holder was well painted inside, and the compressor cylinders lubricated with very dilute alkali. The total quantity of air dealt with in this operation amounted to about 73,500 litres.

A second fractionation of the gas thus collected was obtained by liquefying about 70 or 80 litres at a time in a glass bulb immersed in liquid air boiling under reduced pressure. (A description of this piece of apparatus and its uses has been given by Ramsay and Travers, *Phil. Trans.*, 1901, cxcvii., A, p. 58). Light fractions were boiled off, and the process repeated several times until the volume was reduced to 4700 cc. This portion (1) was separated, by the method of absorption in cooled charcoal, into three fractions, (2) not absorbed at about −190° C., (3) not absorbed at about −110° C., (4) discarded. Spectroscopic examination showed (2) to be almost pure neon and helium with faint hydrogen lines. An attempt was made to fractionate (2) and (3) at the temperature of liquid air boiling at ordinary pressure (−190° C.), but, in the case of (3), the fractions always showed the nitrogen spectrum (see table of fractionations): it was therefore decided to work at the temperature of liquid air boiling under reduced pressure, which represents a temperature about −205° C.

Table of Fractionations.



Speectroscopic examination showed (5) and (6) to be chiefly neon and helium, with a little hydrogen—no new lines were detected; (7) was neon and nitrogen, while (8) and (11) consisted chiefly of nitrogen; (5), (6), and (7) were mixed and separated into the fractions; (14) pumped off at −205° C., (15) at −190° C., (16) and (17) at 18° C., and (18) at 236° C.; (8), (9), (10) were mixed, and similarly separated into fractions (19), (20), (21); (19) gave the nitrogen spectrum, (14), and (15) consisted of neon and helium; (16) and (17) contained hydrogen in addition to neon and helium, while (18) contained more nitrogen than neon. Fractions (14), (15), (16), (17) were therefore analysed for hydrogen, whilst the remaining fractions, as shown by the table, were worked up for neon and helium, of which 25 cc. were obtained. The gases were measured separately, sparked with oxygen, the excess of which was subsequently withdrawn by means of phosphorus. The diminution in volume gave the amount of hydrogen present. The gases were measured by the method described by Ramsay (*Roy. Soc. Proc.*, lxxvi., A, p. 113).

	Cc.		Cc.
Volume of (14)	1·258	Volume of (15)	1·995
„ after sparking	1·260	„ after sparking	2·001
„ of hydrogen .	Nil	„ of hydrogen .	Nil

N.B.—The slight increase in volume represents a small error of measurement of the order about 1 in 400.

	Cc.		Cc.
Vol. of (16)	11·615	Volume of (17)	6·507
„ after sparking..	11·420	„ after sparking	5·924
„ of hydrogen ..	0·195	„ of hydrogen .	0·583

Total volume of hydrogen .. 0·778 cc.

The spectra of (14), (15), (16), (17) were very carefully compared with the spectrum of a neon and helium tube, and they agreed exactly throughout; no new lines could be detected; this also shows that the contractions could not have been due to the presence of carbon monoxide, possibly derived from the charcoal. Any hydrocarbons in the air would have been removed in the charcoal.

As a test of this method of separating a small proportion of hydrogen from air, a parallel series of fractionations was performed on about 60 litres of air, to which 5·6 cc. (measured to 0·1 cc.) of hydrogen had been added. Three fractions were finally obtained from charcoal:—(1) At −205° C., (2) and (3) at −190° C. Analysis, as before, gave the following results:—

1.	4·602 cc. gave 0·170 cc. hydrogen	(3·7 per cent)	
2.	13·005 „ 0·702 „	(5·4 „	)
3.	29·259 „ 1·585 „	(5·4 „	)

Total volume of hydrogen .. 2·457 cc.

* A Paper read before the Royal Society, December 13, 1906.

Thus, only about half the added hydrogen was recovered. The most probable source of loss seems to be in the fractionation from the liquefied gas, when even the passage of air bubbles through the liquid appears insufficient to expel all the hydrogen. Dewar (*loc. cit.*) has also stated that hydrogen is very soluble in liquid air; it is thus possible that a little hydrogen might have been removed puring the initial process with the liquefying machine. It is noteworthy that the fraction pumped from the charcoal at $-205°$ C. contains less hydrogen than that which comes off at $-190°$ C.; the absorption of hydrogen seems to be of about the same order as that of neon.

The total volume of hydrogen obtained from the air was 0·778 cc., and the total volume of mixed neon and helium was 46 cc. Using the estimate of Ramsay (*loc. cit.*) and of Dewar (*loc. cit.*), viz., 60,000 volumes of air contain 1 volume of combined neon and helium, it is found that 2,760,000 cc. of air contain 46 cc. of neon and helium and 0·778 cc. of hydrogen, whence 3,550,000 cc. of air contains 1 cc. of hydrogen. This number can be corrected by assuming, as an approximate factor, the ratio 2·5/5·6 derived from the experiments on the air to which hydrogen had been introduced. The corrected estimate is 1 cc. of hydrogen in 1,583,600 cc. of air, or, approximately, one volume of hydrogen per million and a-half volumes of air.

On comparing the total volume of air originally dealt with, it is evident that the liquefying plant was of very little use in concentrating the lightest portions; it is certainly better to calculate the hydrogen on the quantity of neon and helium actually obtained than on the original volume of air.

It appears from these results that the proportion of free hydrogen in the atmosphere is exceedingly small—so small, indeed, as to make its exact estimation a matter of extreme difficulty, and we must regard our results as indicating the order rather than the exact proportion in which the hydrogen is present.

In conclusion, I wish to express my warmest thanks to Sir William Ramsay, who suggested and constantly superintended the work during its progress.

DETERMINATION OF URANIUM AND VANADIUM.

By A. N. FINN.

A STUDY of the ore carnotite, which is a potassium uranyl vanadate, repeatedly required the determination of uranium and vanadium. This led to a comparison of the various titration methods that have been suggested.

Belohoubek (*Journ. Prakt. Chem.*, xcix., 231) refers to the reduction of uranium in solution by zinc and sulphuric acid, and titration with potassium permanganate. Sutton, in the sixth edition of his "Volumetric Analysis," states that this method is very accurate if care is taken to insure complete reduction, which requires from one-quarter to one-half an hour.

Determinations of uranium by this method in solutions of uranyl sulphate gave very satisfactory results provided the potassium permanganate solution was not more than twentieth-normal. When, however, uranium is to be determined from a complex mixture or an ore, great difficulty is found in securing the uranium in a form sufficiently pure for the titration. This is especially true in the presence of vanadium.

The general method of separating the uranium and vanadium from each other, and from the various other elements in the ore, is to treat an acid solution of the ore with an excess of sodium carbonate, which precipitates the iron, aluminium, &c., and filter. The filtrate containing the uranium and vanadium is acidified, the carbon dioxide expelled by boiling, and the solution is made alkaline with sodium, potassium, or ammonium hydroxide. This precipitates the uranium as the corresponding uranate, while the vanadium remains in solution. The uranate is dissolved in sulphuric acid, reduced with zinc, and titrated with permanganate. The solution of vanadium is acidified, reduced with sulphur dioxide, and titrated with permanganate.

The precipitated uranate is gelatinous, and it was found impossible to wash this precipitate free from vanadium, and since the uranate is slightly soluble it is not desirable to wash or re-dissolve it many times.

In view of this fact, it became necessary to find an accurate and, if possible, a quicker method for the separation and determination of uranium and vanadium.

This was accomplished by precipitating the uranium in alkaline solution as a phosphate. This precipitate, ammonium uranyl phosphate, is not gelatinous, is insoluble, and may easily be washed free from vanadium.

To show that the volumetric method of titrating the reduced solutions with permanganate is consistent in itself, samples of uranium salts containing no vanadium were used, and the following results were obtained.—

Sample.	Grms.	Per cent U_3O_8.
Solution No. I... ..	9·5058	3·195
	5·1820	3·120
	5·0603	3·167
	5·1570	3·135
Solution No. II. ..	10·2941	5·084
	10·2839	5·056
Solution No. III. ..	11·7228	5·228
	4·4641	5·276

Samples of solution No. III. precipitated with ammonia, ignited and weighed as U_3O_8, gave the following results:—

Grms.	Per cent U_3O_8.
3·81955	5·237
5·3409	5·297

For vanadium, material free from uranium was used, and the following results obtained:—

Sample.	Grms.	Per cent V_2O_5.
Solution No. IV. ..	10·7412	0·945
	10·4142	0·946
	11·3310	0·941
	11·4935	0·947
Solution No. V. ..	12·8359	1·338
	12·6929	1·340
	15·2051	1·349
	14·1954	1·339
Solution No. VI. ..	0·3311	39·127
	0·4341	39·170
	0·3004	39·200

The method suggested for determining uranium and vanadium is, in detail, as follows:—

Dissolve a sample of ore that does not contain more than 0·25 grm. of U_3O_8 in sulphuric acid (1:5), and evaporate to fumes of the acid. Cool, dilute, add an excess of sodium carbonate, and boil until the precipitate settles well. Filter, and wash with hot water. Dissolve the precipitate in the smallest possible amount of sulphuric acid, dilute, add an excess of sodium carbonate, boil, filter, and wash. Acidify the combined filtrates and wash-waters with sulphuric acid. Add ammonium phosphate (0·5 grm. is usually sufficient), heat to boiling, and make alkaline with ammonia, boil for a few minutes, filter, and wash with hot water containing a little ammonium sulphate, which prevents the finely divided particles of the precipitate from passing through the paper.

The filtrate now contains the vanadium and the precipitate the uranium. Acidify the filtrate with sulphuric acid, pass sulphur dioxide into it until it becomes blue, boil to expel the excess of sulphur dioxide, and titrate while hot with permanganate. The iron factor of the per-

manganate solution multiplied by 1·631 gives the V_2O_5 factor, or by 0·9159 gives the vanadium factor.

Dissolve the ammonium uranyl phosphate in sulphuric acid, add some granulated zinc, and let the action continue vigorously for at least thirty minutes. Remove the undissolved zinc by filtering over asbestos, using a suction pump, and titrate at about 60° with permanganate (twentieth-normal).

The iron factor of the permanganate solution multiplied by 2·5167 gives the U_3O_8 factor, or by 2·133 gives the uranium factor.

By this method of separation, reducing the solutions, and titrating with permanganate, the following results were obtained :—

Sample.	Grms.	Per cent U_3O_8.	Per cent V_2O_5.
Solution No. VII. ..	10·7904	1·074	1·429
	21·5602	1·068	—
	15·0921	1·085	1·407
	10·6119	1·063	1·415
Ore-carnotite I. ..	1·0002	11·793	6·363
	1·0013	—	6·300
	1·0004	11·885	6·261
Ore-carnotite II. ..	1·0009	6·755	6·849
	2·0005	6·702	6·526
Ore-carnotite III. ..	1·0006	4·873	5·128
	1·0003	4·945	5·358
Ore-carnotite IV. ..	1·00045	1·834	—
	1·00025	1·728	—
Ore-carnotite V. ..	0·9994	0·4094	—
	1·2004	0·4205	—

—*Journal of the American Chemical Society*, xxviii., No. 10.

THE OPTICAL ROTATION OF GLIADIN IN CERTAIN ORGANIC SOLVENTS.

By W. E. MATHEWSON.

THE experiments given here were carried out in connection with an investigation, the object of which was to effect some improvement on the present methods of flour analysis. The work has been interrupted, so it has been thought best to publish these results.

The gliadin used was prepared from a bakers' grade hard wheat flour by extracting with 60 per cent alcohol, filtering the extract until perfectly clear, concentrating and precipitating with absolute alcohol. The crude gliadin thus obtained was again dissolved and precipitated, digested repeatedly with ether, and finally dried over sulphuric acid. All alcohol and ether used had been carefully re-distilled. The preparation was soluble to a perfectly clear and almost colourless solution in dilute alcohol. Duplicate portions contained 17·42 per cent and 17·52 per cent of nitrogen, determined by the Gunning method, the digestion being continued for two hours after the mixture had become colourless. It was thoroughly mixed during and aftet the drying so that the nitrogen determinations might be consistent with the polarimetric observations. It is very probable that the proteid was not quite free from moisture; and the specific rotations obtained have been corrected by multiplying by the factor 1766/1747.

The gliadin was soluble in dilute methyl and propyl alcohols, and in glacial acetic acid, phenol, paracresol, and benzyl alcohol. A white precipitate, presumably gliadin, was produced when the phenol solution was treated with ether, acetone, or pyridine, and somewhat less readily when treated with benzene or chloroform. Pure methyl, ethyl, propyl, and amyl alcohols produced precipitates, the amount required being less the greater the molecular weight of the alcohol. No turbidity followed the addition of several volumes of aniline, phenylhydrazine, or nitrobenzene, but when gliadin was treated with these substances it did not seem to dissolve, and the clear filtrates showed practically no optical activity. It seemed somewhat soluble in benzaldehyde, but the sample of the latter used was not pure.

In order to ascertain whether the gliadin underwent decomposition on dissolving in phenol, about 7 grms. were taken, dissolved in about 100 cc. hot phenol, and the solution, after cooling, poured into about 500 cc. pure benzene. A heavy precipitate was produced, although the addition of a little of the supernatant liquid to benzene caused a further separation of solid material, showing that a considerable amount still remained dissolved. The liquid was decanted off, the precipitate washed repeatedly with benzene, drained with suction, and dried for three weeks over sulphuric acid *in vacuo*. It still retained a faint odour of phenol. Two portions were taken, dissolved in 70 per cent ethyl alcohol, and the solutions polarised. The latter were not absolutely clear, but were sufficiently clear to enable saccharimeter readings to be obtained without difficulty. Ten cc. were taken from the saccharimeter tube, and the nitrogen content determined. From this the specific rotation was calculated, assuming the gliadin to be equal to the nitrogen multiplied by 10000/1766. The following are the data :—

Saccharimeter reading, 40° C.		
100 mm. tube	−4·53° V.	−5·45° V.
Grm. of nitrogen in 100 cc.		
at 40° C.	0·3051	0·3678
$[\alpha]_D$ 40° C.	−90·95	−90·76

The specific rotation of the substance seems to have suffered but little change. It gave the biuret reaction and the red purple coloration with diluted sulphuric acid exactly as does pure gliadin. A solution of gliadin in phenol, giving a saccharimeter reading of −19·7° V. (200 mm. tube), was sealed up in a glass bulb and maintained at a temperature of about 140° in an air-bath for three and one-half hours. It then gave a reading of −18·4° V.

The solutions of gliadin in glacial acetic acid and in benzyl alcohol gave precipitates with ether exactly resembling gliadin in appearance, and which dissolved readily in dilute alcohol. These latter solutions gave the biuret reaction.

The specific rotations of the gliadin were obtained with a triple shadow saccharimeter, a jacketed tube being used for the solution. The following are the data :—

Solvent.	Grm. gliadin per cc. at 40°.	Saccharimeter reading in Ventzke degrees.	$[\alpha]_D$ 40. Degrees.
Methyl alcohol, 70 per cent	0·03644	−19·81	−95·3
,, 70 ,,	0·03366	−18·42	−96·0
Ethyl alcohol, 70 ,,	0·03085	−16·21	−92·1
,, 70 ,,	0·04499	−23·55	−91·8
,, 60 ,,	0·02264	−12·52	−96·9
,, 60 ,,	0·02388	−13·13	−96·4
,, 60 ,,	0·03126	−17·25	−96·7
,, 50 ,,	0·02895	−16·29	−98·6
,, 50 ,,	0·04914	−27·55	−98·3
Propyl alcohol, 60 ,,	0·02990	−17·07	−100·9
,, 60 ,,	0·03015	−17·42	−101·3
Phenol, 70 ,,	0·02035	−14·25	−122·7
,, 70 ,,	0·03340	−23·56	−123·6
Phenol, anhydrous	0·02824	−21·31	−132·2
,, ...	0·03018	−22·73	−132·0
,, ...	0·04288	−32·07	−131·1
Paracresol	0·02799	−19·54	−121·0
Glacial acetic acid	0·04267	−19·69	−80·9
,, ...	0·05014	−22·48	−78·6
Benzyl alcohol	0·02282	−6·91	−53·1
,, ...	0·03050	−10·14	−58·3

The methyl and propyl alcohols and the phenol used were the chemically pure grades from well-known manu-

facturers, and were fractionated before use. The acetic acid and cresol were chemically pure grade, but were not further purified. The benzyl alcohol was fractionated. It had a boiling-point of about 202° (uncorrected). The aromatic compounds were tested for optical activity.

The divergence in the results obtained with the benzyl alcohol is doubtless due to the decomposition of a part of the proteid by the heating necessary to bring it into solution. The sample giving the lower reading was purposely kept at a high temperature considerably longer than the other to see if the rotation would be markedly changed. Doubtless the other determinations are also affected with some error due to the same cause, although this was guarded against as far as was practicable.

The fact that gliadin is soluble in phenol would seem to render possible an approximate determination of its molecular weight by the freezing-point method. Since it is also soluble in boiling 70 per cent propyl alcohol, a determination by the boiling-point method might be made, since G. N. Lewis has shown (*Journ. Am. Chem. Soc.*, xxviii., 766) that Raoult's law regarding the elevation of the boiling-point can be applied to a binary solvent whose vapour has the same percentage composition as the liquid. The presence of traces of moisture would affect the results by the latter method much less, although gliadin is doubtless more or less altered by continued warming with any solvent containing water.

An attempt has been made to estimate the gliadin present in flour by digestion with phenol and polarisation of the filtered extract. The results obtained seem to indicate that a quite complete extraction of the gliadin is effected. It is possible, however, that more or less glutenin also dissolves in the phenol. The chief difficulty encountered is in the filtration of the mixtures.—*Journal of the American Chemical Society*, xxviii., No. 10.

THE DETERMINATION OF TUNGSTIC ACID IN WOLFRAMITE ORES AND CONCENTRATES.*

By HUGH F. WATTS, Boulder, Colorado.

On account of the tungsten production that has taken place in Colorado in the last few years, and which bids fair to be maintained, the following method of analysing its ores, while presenting nothing especially new, nevertheless may be found of interest:—

The samples of ores or concentrates, as they come to the assay office, are generally already prepared; if not, they should be made to pass a 100-mesh screen. A portion of the sample is then finely ground in an agate mortar, and, as much of the success of the determination depends on the fineness, it is necessary that this part of the operation be thoroughly done, as a few extra minutes spent in grinding may prevent the necessity of a second acid treatment.

One grm. of the finely ground material is then transferred to a four-ounce beaker and treated with 50 cc. concentrated hydrochloric acid and 15 cc. concentrated nitric acid, covered with a watch-glass and set on the hot plate. The degree of heat should be such that there is a gentle action of the acids on the mineral, but the solution should not actually boil. The decomposition takes about four hours and the solution should be occasionally well stirred up. At the end of this time the solution will have evaporated to about 10 cc. to 15 cc. and the walls of the beaker will be slightly covered with tungstic acid. It is not necessary to carry the evaporation to dryness, but if this is done, care must be taken not to overheat the residue, as otherwise the separated tungstic acid is rendered difficultly soluble in ammonia.

To the residue in the beaker add 50 cc. hot water and allow to settle for half-an-hour. Decant the clear solution through a good filter paper. The residue settles readily and can be decanted close. Wash the residue twice more by decantation, using each time 50 cc. hot water and 5 cc. hydrochloric acid, keeping as much of the residue in the beaker as possible. The use of hydrochloric acid in the wash water is to keep the tungstic acid from running through, which it has a tendency to do when washed with pure water.

The tungstic acid is now separated from the silica with dilute ammonia containing a small amount of ammonium chloride. It is convenient to have the ammonia in a small wash bottle (a four-ounce wash bottle is sufficient) containing 1 to 10 ammonia, to which is added 1 cc. strong hydrochloric acid. This small amount of ammonium chloride prevents silica from running through with the dissolved tungstic acid, and which it is disposed to do when washed with ammonia alone.

About 25 cc. of the ammonia solution are added to the beaker, washing off the cover glass and dissolving that which adheres to the sides. The tungstic acid readily goes into solution and is decanted through the filter to dissolve out all the acid retained. The residue of silica is now brought on the filter and washed thoroughly with the ammonia solution. The resulting silica should be white; if it shows any particles of undecomposed mineral, the decomposition must be repeated, using 25 cc. aqua regia, which will generally complete the work. One trial is all that is usually necessary if the ore has been finely ground and frequently stirred.

The ammoniacal solution is now evaporated, either in a weighed platinum or porcelain crucible. A 2½-inch porcelain is preferable on account of the facility with which the evaporation can be conducted. For my own use, for this evaporation, I employ an air bath of shallow construction, heated with Bunsens, and capable of holding four crucibles upon which the operation is carried on with a considerable saving of time over that required when a water bath was used.

When evaporation is complete, the crucible is heated over a Bunsen, gently, at first, to drive off ammonium salts, and finally at the highest heat of the burner, rotating the crucible to expose fresh surfaces to the heat. It is not desirable to use a blast for this purpose, as tungstic acid is slowly but steadily volatilised by an excessive heat.

The crucible is then cooled in a desiccator and weighed as tungstic acid. This is the form in which it is usually reported. If metallic tungsten is required the factor is 0·7931.

The acid, which adheres somewhat strongly to the crucible, can be removed by soaking over night in dilute ammonia. Then with the aid of a little silica, or, better still, powdered fluor-spar, and the finger, it can be readily and completely cleaned.

In the above scheme I have not found that the resulting tungstic acid contains more than inappreciable amounts of silica. If, however, the ammoniacal filtrate is in any way turbid, it is necessary to test for its presence. If the final evaporation has been made in platinum, this can be done by expelling the silica with hydrofluoric acid and re-weighing.—*Western Chemist and Metallurgist*, July, 1906.

Royal Institution.—On Tuesday next, January 15, at 3 o'clock, Professor Percy Gardner delivers the first of two lectures at the Royal Institution on "The Sculpture of Aegina in relation to Recent Discovery"; on Thursday, January 17, at 3 o'clock, Dr. W. N. Shaw begins a course of two lectures on "Recent Advances in the Exploration of the Atmosphere"; and on Saturday, January 19, at the same hour, Sir Alexander Mackenzie commences a course of two musically illustrated lectures on "Latest Phases of Music." The Discourse on January 18 will be delivered by Sir Andrew Noble, Bart., K.C.B., on "Fifty Years of Explosives," and on January 25 by Mr. C. Welch on "The Guildhall Library." Professor W. W. Watts being unable to deliver his two lectures on the "Building of Britain" and "Recent Light on Ancient Physiographies" on Thursdays, February 14 and 21, Mr. Alfred Harker will deliver two lectures on those dates on "The Minute Structures of Igneous Rocks, and their Significance."

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting December 20th, 1906.

Prof. R. Meldola, F.R.S., President, in the Chair.

The President announced that the following congratulatory telegram had been sent this day to Prof. Adolph Lieben (Honorary and Foreign Member of the Society), on the occasion of his seventieth birthday and the fiftieth anniversary of his Doctorate.

"Hearty congratulations to our Honorary and Foreign Member, Dr. Adolph Lieben, from the Chemical Society, London.—Meldola, President."

Messrs. W. R. S. Ladell, W. T. Lattey, and J. Mastin were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Alfred Frederick Allen, B.Sc., 35, Parrett Road, Plumstead, S.E.; Henry Bassett, jun., B.Sc., Ph.D., 26, Belitha Villas, Barnsbury, N.; John Christie, B.A., Eton College, Windsor; Francis Davidson, Dover Place, Ashford, Kent; William Smith Denham, B.Sc., 2, Kelvinside Terrace North, Glasgow; George Fowles, 28, Weltje Road, Hammersmith, W.; William Godden, B.Sc., Station Road (East), Canterbury; Charles Pask Matthews, B.Sc., 6, Fortress Road, N.W.; Charles Schlienger, B.Sc., 273, Camden Road, N.; William George Sewell, B.Sc., 27, Park Road, Wandsworth Common, S.W.; Frederick George Shepheard, B.Sc., 9, Leinster Road, Rathmines, Co. Dublin.

Of the following papers, those marked * were read:—

*221. "*A New Laboratory Method for the Preparation of Hydrogen Sulphide.*" By Frederick Robert Leyland Wilson.

The common method for the preparation of hydrogen sulphide by the interaction of hydrochloric acid and ferrous sulphide is open to several objections, the most serious of which is the liability of the gas to contain the hydrides of arsenic and phosphorus, due to the contamination of the iron sulphide with phosphide and arsenide. The method here described ensures freedom from these impurities, as well as the absence of most of the unpleasant accompaniments of the ordinary process of preparation.

If a current of hydrogen sulphide is passed over an alkali hydroxide, for example, sodium or calcium hydroxides, a hydrosulphide is formed, heat being evolved and a change in colour from white to yellow taking place. If a current of carbon dioxide is now passed over the hydrosulphide, the compound is at once decomposed, a carbonate being formed and hydrogen sulphide set free.

In the case of calcium hydroxide, the yellow substance has the composition Ca(HS)(OH), and the action of carbon dioxide is given by the equation $Ca(HS)(OH)+CO_2=CaCO_3+H_2O+H_2S$.

A drying tower is filled either with granular soda-lime or an intimate mixture of calcium hydroxide and moist sawdust. A stream of hydrogen sulphide is passed into the tower until the contents are saturated with the gas, the course of the action being easily determined by the change in colour and by the movement of a heated zone upwards through the tower.

After the action has proceeded for some time the gas which escapes from the exit tube smells strongly of hydrogen phosphide and is inflammable, doubtless consisting of hydrogen mixed with all the other gaseous impurities evolved by the action of acid on the ferrous sulphide.

When the hydroxide has reacted with as much hydrogen sulphide as possible, a carbon dioxide generator is substituted for that supplying hydrogen sulphide, and the apparatus is ready to yield as slow or rapid a supply of the latter gas as may desired.

The supply of hydrogen sulphide ceases at once when the stream of carbon dioxide is cut off, and if the exit tube from the tower is closed, a partial vacuum will soon be produced owing to combination of the gases in the tower with unaltered hydroxide.

Owing to this absorption of the gas in the tower, it is only necessary to cut off the supply of carbon dioxide in order to prevent further escape of hydrogen sulphide.

The rate of supply of the gas may be nicely regulated by introducing a short length of capillary glass tubing between the carbon dioxide apparatus and the generating tower.

The danger of contamination of the hydrogen sulphide with carbon dioxide is very small, and may be entirely eliminated by making use of two towers. As soon as the first shows signs of exhaustion (indicated when calcium hydroxide is used, by the change in colour), it is replaced by the second tower; a new one is put in place of the latter, and the supply of gas taken from this.

Discussion.

The President asked how the method compared with the known laboratory process of preparing hydrogen sulphide by heating sulphur with certain hydrocarbons such as solid paraffin.

Mr. Wilson stated that he had not compared the two methods.

*222. "*The Affinity Constants of Aminocarboxylic and Aminosulphonic Acids as Determined by the Aid of Methyl-orange.*" By Victor Herbert Veley.

The method of determining the affinity constants of acids by means of a very dilute methyl-orange solution and a tintometer described in a former paper (*Zeit. Physikal. Chem.*, 1906, lvii., 147), as applied to the carboxylic acids and certain chloro- and hydroxy-derivatives, has been extended to the aminocarboxylic and aminosulphonic acids. It is shown that the same general mathematical expressions hold good, namely, those of straight lines $y=kx$ or $y=kx-b$, or logarithmic curves $\log y=\log k+x\log a$.

Acids which show irregularities in the Ostwald electric conductivity expression $\phi(k)=a^2/(1-a)V.(a=\mu/\mu_\infty)$ likewise show similar irregularities in the methyl-orange method.

The aliphatic aminocarboxylic acids act as neutral substances, but their hydrochlorides as hydrochloric acid only, hydrolysis being nearly complete at the degree of dilution used.

The special cases of asparaginic acid, as possessing a higher affinity factor than succinic acid, and of cacodylic acid, as allied to amphoteric electrolytes, have been investigated.

The aminobenzoic acids show a distinct acid function, and the results obtained are in a similar arithmetical ratio to those deduced by Winkelblech (at a different degree of dilution) by the electric conductivity method.

The two aminobenzenesulphonic acids studied, namely, sulphanilic (1 : 4) and metanilic (1 : 3) acids are remarkable in that the latter conforms to the straight line, but the former to the logarithmic expression.

The introduction of a second sulphonic grouping diminishes rather than increases the acid function.

A study of the naphthylamine mono- and di-sulphonic acids (eighteen in number) affords examples of steric "furtherance" as regards the positions 2 and 7 relative to 1, and of steric hindrance as regards the position 8 relative to all other positions.

Discussion.

Dr. Cain suggested that, as the 1-naphthylamine-8-sulphonic acid exhibited the phenomenon of "steric hindrance" and the 1-naphthylamine-2-sulphonic acid that of "steric furtherance," it would be of interest to know the behaviour of the 1-naphthylamine-4-sulphonic acid, particularly as this underwent molecular change into the 1 : 2-acid by the action of heat.

Dr. Hewitt asked if there was any definite stage between the colour of methyl-orange in alkaline and in acid solution. He had himself compared the absorptions of methyl-orange and butter-yellow, and found that the

solutions of dimethylaminoazobenzene and sodium dimethylaminoazobenzenesulphonate, on the one hand, and the salts of butter-yellow and acidified solutions of methyl-orange on the other, gave practically identical absorption spectra. Any intermediate coloration between that of the free sulphonic acid and its sodium salt might be explained by partial neutralisation, and this opinion is confirmed by the fact that dimethylaminoazobenzenesulphonic acid in solution gives practically the same absorption as solutions of methyl-orange with an excess of mineral acid. The supposed free acid of methyl-orange would thus appear to be an internal salt.

The President asked whether special precautions had been taken to ensure the purity of the naphthylaminesulphonic acids used by the author, since the technical preparations supplied were professedly impure from the chemical point of view, and the difficulty of obtaining homogeneous products from mixtures of isomerides was often very great. With respect to the question of the proximity of position 8 as compared with position 2 relatively to position 1 in the naphthalene ring, he did not think that enough was known about the actual configuration of the atoms in the molecule to enable any dogmatic statement to be made.

Dr. Veley, in reply, said that it would be unwise to express any dogmatic views as to the relative contiguity of substituent groupings in the naphthalene nucleus. As regards the position 4, a difficulty had arisen on account of the sparing solubility of the 1-naphthylamine-4-sulphonic acid. The acids had been purified previous to use by recrystallisation or otherwise. He felt some hesitation in discussing the actual composition of the yellow, orange-red, and red shades of methyl-orange, but it was clear that the last was the result of some more profound chemical change. In any case the hypothesis of migratory ions appeared to be too speculative.

*223. "*Contributions to the Study of the Calcium Phosphates. I. The Hydrates of the Calcium Hydrogen Orthophosphates.*" By Henry Bassett, jun.

Although numerous hydrates of dicalcium phosphate have been mentioned in the chemical literature, the author's experiments show that, in all probability, dicalcium phosphate can only form one hydrate, namely, the dihydrate.

The experiments also allow of some conclusions being drawn as to the position of certain of the quintuple points on the space model of the three-component system, $CaO—P_2O_5—H_2O$.

There are indications that the point at which the phases present are $CaHPO_4,2H_2O$, $CaHPO_4$; solid solutions (see the papers by Cameron and Seidell in *Journ. Am. Chem. Soc.*, 1905, xxvii., 1503, and Cameron and Bell, *Journ. Am. Chem. Soc.*, 1905, xxvii., 1513); liquid solution and vapour lies at about 80°; whilst the point at which the phases $CaH_4(PO_4)_2,H_2O$, $CaHPO_4,2H_2O$, $CaHPO_4$, liquid solution and vapour can co-exist lies at about 30°.

The monocalcium phosphate has also been studied, and it has been found possible to prepare the crystallised anhydrous salt. This compound can be obtained in long bright prisms by crystallisation at 160° of a solution of calcium carbonate in orthophosphoric acid if the ratio of P_2O_5/CaO in the solution is sufficiently large. The best value for this ratio was found to be 4·6. If it is less than 3·0, then, even at 160°, the monocalcium phosphate monohydrate crystallises out.

*224. "*Contributions to the Study of the Calcium Phosphates. II. The Action of Ammonia Gas on the Calcium Hydrogen Orthophosphates.*" By Henry Bassett, jun.

It was found that under certain conditions when the acid calcium phosphates were treated with ammonia gas, absorption of the latter took place. The cause of this and the reactions occurring have been investigated with the following results:—

$CaHPO_4$ does not absorb ammonia either at the ordinary temperature or at 100°.

$CaHPO_4,2H_2O$ does not absorb ammonia at the ordinary temperature, but if heated in the gas to 100°, vigorous absorption takes place with formation of a mixture of tricalcium- and ammonium phosphates according to the equation—

$$3CaHPO_4,2H_2O + 2NH_3 = Ca_3(PO_4)_2 + (NH_4)_2HPO_4 + 6H_2O$$

When $CaHPO_4,2H_2O$ is heated, it would seem that at a temperature of about 80°, one of the quintuple points of the system $CaO—P_2O_5—H_2O$ is reached. At this temperature the dihydrate breaks up into a mixture of $CaHPO_4$, $Ca_3(PO_4)_2$ and solution, and it is in this solution that the above reaction with ammonia takes place.

$CaH_4(PO_4)_2$ absorbs ammonia very slowly at the ordinary temperature, but rapidly at 100° with formation of the compound $Ca(NH_4)_2H_2(PO_4)_2$. This compound is not stable in presence of water, which at once decomposes it into $CaHPO_4$ and $(NH_4)_2HPO_4$. This explains why, when $CaH_4(PO_4)_2H_2O$ reacts with ammonia gas, a mixture of $CaHPO_4$, $Ca_3(PO_4)_2$, and $(NH_4)_2HPO_4$ is formed.

The commencement of the ammonia absorption by the $CaH_4(PO_4)_2,H_2O$, is probably due to formation of the above calcium ammonium phosphate. This, however, liberates water of crystallisation, which at once forms some solution in which the reaction proceeds. Although this reaction first leads to the formation of $CaHPO_4$, this can further react with ammonia as long as any solution is present.

It is to this further reaction that the presence of $Ca_3(PO_4)_2$ in the final product is due.

Discussion.

Dr. Veley asked if the author had dried the ammonia gas, and if the phosphates experimented upon were quite free from traces of adherent moisture. It appeared that the subsequent solution in water of the products obtained introduced a very essential disturbing factor.

Dr. Bassett, in reply, said that the ammonia used had been dried by passing over solid caustic soda and sodium wire, but, of course, such ammonia was not absolutely dry. The calcium phosphates used in the experiments were also as free from adherent moisture as was possible without extreme precautions. With regard to the examination of the reaction products by treatment with water, the author realised the dangers of the method and the possibility of reactions occurring during this treatment. The method had, however, been employed as being the only one which would enable one to distinguish between, for instance, a mixture of $Ca_3(PO_4)$ and $(NH_4)_2HPO_4$, and a compound $Ca(NH_4)PO_4$, and he considered that the difficulty caused by possible reactions during the extraction with water had been satisfactorily overcome in each particular case in the manner described in the paper.

*225. "*Relation between Chemical Constitution and Physiological Action in the Tropeines.*" By Hooper Albert Dickinson Jowett and Frank Lee Pyman.

Reference was made to Ladenburg's generalisation, according to which a tropeine in order to possess mydriatic action must contain a benzene nucleus and a fatty hydroxyl in the side chain containing the carboxyl group, and also to a recent paper by Jowett and Hann (*Trans.*, 1906, lxxxix., 357), in which it was stated that terebyl- and phthalidecarboxyl-tropeines, which are lactones, and do not contain fatty hydroxyl groups, produce, nevertheless, marked dilatation of the pupil, and lose their physiological activity when converted into the corresponding hydroxy-acids.

The authors have prepared the *lactone* of *o-carboxyphenylglyceryltropeine*, expecting to find it very active physiologically, since it is not only a lactone, but also conforms to Ladenburg's generalisation, *isocoumarincarboxyltropeine*, which results on heating the above, and certain alkyl bromides of these tropeines and of homatropine.

The physiological examination showed that these tropeines are only slightly mydriatic, and that their

physiological activity is lost when they are converted into the corresponding hydroxy-acids. The authors conclude that Ladenburg's generalisation cannot be maintained, since it does not hold good either in the case of terebyltropeine or of the lactone of *o*-carboxyphenylglyceryl tropeine, but that the difference in activity between a lactone and its corresponding hydroxy-acid possesses important physiological significance.

(To be continued).

PHYSICAL SOCIETY.

December 14th, 1906.

SECOND ANNUAL EXHIBITION OF ELECTRICAL, OPTICAL, AND OTHER PHYSICAL APPARATUS.

MESSRS. R. and J. BECK, Ltd.—Microscopic Resolution with Monochromatic Light. Wave-Length Spectroscope.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT Co., Ltd.—Ballistic Balance. Optical Bench. Callendar and Griffiths's Wheatstone Bridge. Recording Mercury Thermometer. Chronograph for recording variations in speed. Chronograph for Morse Paper. New type of Oil-Bath Oscillograph. Burton's Anti-Vibration Stand.

Messrs. CASELLA and Co.—6-inch Transit Theodolite. Alpine Transit Theodolite. Whipple-Casella Universal Sunshine Recorder. Anderson's Patent Slide-Rule. Recording Pressure-Guage. Portable Dip Circle. Casella's Patent Self-Recording Anemometer.

Messrs. CROMPTON and Co.—Portable Testing Set. Steam Car Pyrometer. Electrical Pyrometer for Boiler Installation.

Messrs. ELLIOTT BROS.—Simple Astatic Galvanometer. Glass Cylinder Galvonometer. Brass Case Galvanometer. Moving-coil Galvanometer. Five-dial Wheatstone Bridge. Standard Resistances. Perforator with Desk and Stand. Portable Fault-Localising Bridge. "Century" Mains Test Set. Subdivided Condenser. Set of Die Castings. Simplex Indicator. Harrison Universal Photometer. Key Repeater Boatd.

Messrs. EVERETT, EDGECUMBE, and Co.—Iron-clad Wattmeter for General Purposes. "Universal" Moving-iron Ammeters and Voltmeters. Adjustable Resistances for Laboratory Purposes. Combined Standard Ammeter and Voltmeter. Frequency Indicator, of the Resonance Pattern. Direct-reading Resistance Bridge.

Messrs. EVERSHED and VIGNOLES.—Apparatus for measuring resistance.

Messrs. GAMBRELL BROS.—Standard Inductance. Galvalnometer with strained suspension. Galvanometer with levelling screws. Carey-Foster Bridge. Universal Shunt. Series Resistance Box, Reversing Switches. Testing Set.

Messrs. A. HILGER, Ltd.—Spectrophotometer, with Attachment for using also as a Spectro-polarimeter. Lummer Parallel Plate Spectroscope.

Messrs. NALDER BROS. and THOMPSON, Ltd.—Portable Standard Testing Sets. Portable Instruments, Ammeters and Voltmeters. Portable Insulation Testing Set: The "Ohmer."

Messrs. NEWTON and Co.—Goold's Vortex Plates. Goold's Vortex Plates, showing Dispersion figures.

Mr. R. W. PAUL.—Duddell-Mather Standard Wattmeters. Duddell-Mather Gauze Resistances. Reflecting and Pivoted Electrostatic Voltmeters. Reflecting Galvanometer, with New Scale Stand and Nernst Lamp. Shunt-boxes. Campbell Standard Bifilar Galvanometer. Resistance Standards. Portable Galvanometers. Paul-Harris Test Wire. Portable Testing Sets, Milli-voltmeters, and Micro-ammeters. Nernst-Paul Lamps and Lanterns. Universal Pyrometers, and a small Electric Muffle Furnace.

Messrs. JAMES PITKIN and Co.—Holden D'Arsonval Galvanometers. Pitkin-White Pivoted Moving-coil Galvanometers. Electrical Pyrometers. Resistance Boxes, Standard Cells, Scale Stands. Measuring Instruments.

Messrs. REYNOLDS and BRANSOM, Ltd.—Universal Science Lantern. "Rystos" Electric Lantern with Capstan Arc Lamps. "R. and B." Electric Arc Lamp. R. and B. "Phœnix" Focus-keeping Arc Lamp. R. and B. Patent "Capstan" Arc Lamp. "Rystos" Photo-Micrographic Apparatus, "Rystos" Lantern Microscope. Barr and Stroud's Lantern Slide Apparatus. "Rystos" Reflecting Galvanometer. "Rystos" Electric Dark Room Lamps. Geometrical Models.

Messrs. Ross, Ltd.—"Standard" Petrological Microscope (No. 2). "Standard" Metallurgical Microscope (No. 2). Combination Lantern.

Messrs. J. SWIFT and SON.—Petrological Microscope.

DR. W. M. WATTS.—Binocular Diffraction Spectroscope.

Messrs. ALEXANDER WRIGHT and Co.—Simmance and Abady Patent Combustion Recorder.

Messrs. CARL ZEISS.—Abbe Refractometer with Heating Arrangement. Butter Refractometer. Measuring Microscope for Metal Testing. Microscope for Measuring Capillary Tubes. Dipping Refractometer.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliii., No. 26, December 24, 1906.

A Colloidal Compound of Thorium with Uranium.—Béla Szilard.—On precipitating a hydrate of thorium with ammonia, washing well with warm water, and then mixing the precipitate with a solution of uranium nitrate, the mixture undergoes no change. On raising the temperature, the hydrate loses its white colour, and becomes reddish, the solution having formed a colloidal mixture with the precipitate. Various means were tried for the investigation of this phenomenon, the most successful being the preparation of the body by another method. A solution of $UO_2(NO_3)_2$ (about 2 per cent) was prepared, boiled, and mixed with the freshly prepared and well washed hydrate of thorium, until only a red liquid remained (the hydrate of thorium itself is dissolved in the clear liquid). This red colour is not intensified by increasing the relative amount of uranium, but it is intensified by increasing the quantity of thorium, which seems to corroborate the hypothesis that the body is a compound. The colloidal solution of thorium hydrate prepared with thorium nitrate has no reaction similar to that with uranium nitrate. The chloride, UO_2Cl_2, may be substituted for the nitrate of uranium with the same effect, but in this case the colour is yellowish red; with the acetate and sulphate of uranium, the reaction proceeds much more slowly. Analysis gives the following percentage composition of the body:—Th, 72—74; U, 4—5·5; H_2O, 12—13; O, 10—11, per cent. Zirconium and some other bodies possess, equally with thorium, this property of forming colloidal compounds with salts of uranium.

The Absolute Atomic Weight of Dysprosium.—Gustave D. Hinrichs.—In his recently published results of his determinations of the atomic weight of dysprosium (*Comptes Rendus*, 1906, cxliii., p. 598), G. Urbain has carefully pointed out the degree of purity of the products employed by him. This circumstance gives, with regard to the question of *absolute atomic* weights, a greater importance to his new work than to his work on the atomic weight of terbium reviewed previously (*Comptes Rendus*, 1906, cxlii., p. 1196). M. Urbain gives two series of determinations; the first referring to his treatment of nitrates, and giving only a "first approximation"; the second to his treatment of ethylsulphates, in which the earths were in a state of greater purity. In his calcula-

tions, M. Urbain adopted H = 1·007 and S = 32·06, which values have been shown to be erroneous since 1892. Hence the values calculated do not accord with the degree of purity attained. The author therefore applies to the experimental results of M. Urbain the method of absolute calculation already worked out in the case of his determinations of the atomic weight of terbium. M. Urbain weighed the crystallised sulphate, and the residue left by this salt after calcination. For Dy = 162·5 the atomic weight of the crystallised sulphate, $Dy_2(SO_4)_3 + 8H_2O$, is 757, and the atomic weight of the oxide, Dy_2O_3, is 373 exactly; for the absolute values H = 1 and S = 32 exactly. The atomic ratio is $\frac{\text{oxide}}{\text{sulphate}} = \frac{373}{757} = 0.49273$; the analysis of M. Urbain give the following analytical excesses :—

Fractions.	Experimental results (G. Urbain). Sulphate (grms.)	Oxide (grms.).	Calculation of experimental results (G. D. Hinrichs). Analytical ratio.	Analytical excess.
	Series I.			
35 I. ..	1·6965	0·8359	0·49269	−4
35 II. ..	2·0926	1·0301	226	−47
38 I. ..	1·8415	0·9069	248	−25
38 II. ..	1·5519	0·7649	288	+15
41 I. ..	2·4955	1·2296	273	0
41 II. ..	1·8130	0·8927	239	−34
	Series II.			
9 I. ..	1·8817	0·9271	0·49269	−4
9 II. ..	1·1164	0·5500	266	−7
8 I. ..	1·7308	0·8528	272	−1
8 II. ..	2·6038	1·2820	236	−37
7 I. ..	1·6942	0·8346	262	−11
7 II. ..	2·1776	1·0726	256	−17

The analytical excesses are in perfect agreement with the indications of purity given by the eminent analyst. For the first series (earths arising from the nitrates) the variations of the two determinations made for each fraction are :

No. 35	From	−4 to −47	about 43
„ 38	„	−25 „ +15	„ 40
„ 41	„	0 „ −34	„ 34
	Mean		39

For the second series (earths arising from the ethyl sulphates) :—

No. 9	From	−4 to −7	about 3
„ 8	„	−1 „ −37	„ 36
„ 7	„	−11 „ −17	„ 6
	Mean		15

Therefore the variation of the second series is less than half that of the first. Further, the extreme values in the first are −47 and +15, corresponding to a total variation of 62; while in the second series the extreme values are −1 and −37, corresponding to a total variation of 36. It is remarkable that the fraction giving the most accurate values, *i.e.*, those showing the least analytical excesses, is the fraction No. 9, which M. Urbain considers the purest of all. This agreement between experiment and calculation cannot be regarded as fortuitous, and it must therefore be concluded that the absolute atomic weight of dysprosium is 162·5 exactly.

The Definite Compounds formed by Chromium and Boron.—Binet du Jassonneix.—The reduction of chromium oxide by boron in the electric furnace in crucibles of magnesium yields fusions containing from 5 to 17 per cent of boron combined with chromium; a systematic study of their properties has been made in order to classify and isolate the definite compounds which they might contain. Specimens containing percentages of boron varying from 4·9 to 11·6 were examined; microscopic examination showed that these bodies consisted of two different substances, one acting as a kind of cement to the other, which increased in proportion to the percentage of boron; the specimen with 11·6 per cent boron is almost homogeneous. The results after several analyses, on the lines indicated in a previous note, were as follows :—

	I.	II.	III.	IV.	V.	VI.	Theoretical for Cr_3B_2.
Percentage boron ..	11·9	12·1	12·2	12·2	12·4	12·6	12·3
Percentage Cr . ..	87·3	87·4	87·7	87·5	—	87·2	87·7

Thus the existence of a definite compound of formula Cr_3B_2 is confirmed. Another series of experiments, conducted on specimens containing from 16 to 17 per cent boron, which were found to consist almost entirely of one only of the two definite media, led to the discovery of the definite compound CrB :—

	I.	II.	III.	IV.	Theoretical for CrB
Percentage B..	17·3	17·2	16·9	17·1	17·4
„ Cr..	82·5	82·5	82·8	82·4	82·6

Hence the fused products of chromium and boron contain two definite compounds, Cr_3B_2 and CrB, dissolved respectively in a medium less rich in boron.

Anhydrous Protoxides of the Alkali Metals.—E. Rengade.—The author has prepared protoxides of rubidium, potassium, and sodium, never before obtained in a pure state, by applying to these metals the method by which he had already obtained the protoxide of cæsium. Thus the partial oxidation of the alkali metals, followed by distillation *in vacuo* of the excess of the metal, produces in a pure state the anhydrous protoxides, Cs_2O, Rb_2O, K_2O, and Na_2O; but these do not crystallise readily as in the case of cæsium protoxide.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertisement columns.

Filter Press.—We shall shortly be requiring to purchase a filter press, and should be greatly obliged if any reader would give us information as to the best firms to whom to apply for this apparatus.—C. R. L.

MEETINGS FOR THE WEEK.

Tuesday, 15th.—Royal Institution, 3. "The Sculpture of Aegina in Relation to Recent Discovery," by Prof. Percy Gardner, Litt.D., &c.
— Society of Arts, 4.30. "The Progress of the Uganda Protectorate," by George Wilson, C.B.
— Faraday Society, 8. "Application of the Electron Theory to Electrolysis," by E. E. Fournier D'Albe.

Wednesday, 16th.—Society of Arts, 8. Adjourned Discussion on Mr. J. W. Gordon's paper on "Patent Law Reform."
— Microscopical, 8. Annual Address by the President, "The Flowering Plants of the Mesozoic Age in the Light of Recent Discoveries." Exhibition of Mounted Specimens of Freshwater Polyzoa, by Mr. Rousselet.

Thursday, 17th.—Royal Institution, 3. "Recent Advances in the Exploration of the Atmosphere," by W. N. Shaw, M.A., &c.
— Chemical, 8.30. "Relation between Absorption Spectra and Optical Rotatory Power—Part I., Effect of Unsaturation and Stereoisomerism," by A. W. Stewart. "Organic Derivatives of Silicon—Part II., Synthesis of *dl*-Ethyl-propyl-benzyl-silicol, its Sulphonation, and the Resolution of the Sulphonic Derivatives into Optically Active Compounds," by F. S. Kipping. "Association of Phenols in the Liquid Condition," by J. T. Hewitt and T. F. Winmill. "A New Mercuric Oxychloride," by J. T. Hewitt. "Aromatic Selenonium Bases," by S. Smiles and T. P. Hilditch. "Relation of Colour and Fluorescence to Constitution," by A. G. Green. "Constitution of Silver Nitrite" (a Correction), by E. Divers. "Preparation of Chromyl Chloride," by F. D Law and F. M. Perkin. "Tetraketopiperazin," by A. T. de Moulpied and A. Rule.

Friday, 18th.—Royal Institution, 9. "Fifty Years of Explosives," by Sir Andrew Noble, Bart., K.C.B., &c.

Saturday, 19th.—Royal Institution, 3. "Latest Phases of Music" (with Musical Illustrations), by Sir Alexander C. Mackenzie, Mus. Doc., &c.

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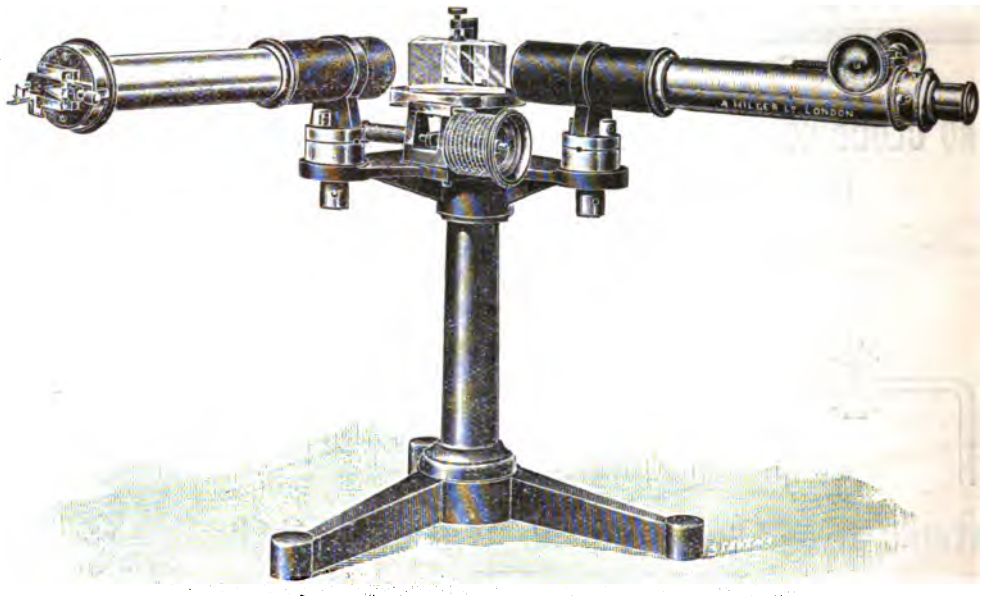

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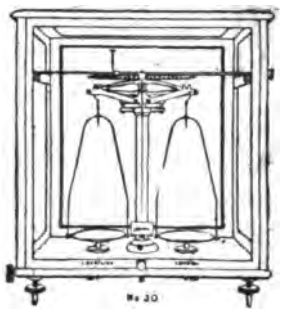

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VOL. XCV., No. 2460.

CALCIUM AS AN ABSORBENT OF GASES FOR THE PRODUCTION OF HIGH VACUA AND SPECTROSCOPIC RESEARCH.*

By FREDERICK SODDY, M.A., Lecturer in Physical Chemistry in the University of Glasgow.

(Continued from p. 15).

V. *Behaviour of Barium and Strontium.*

TESTED under the same conditions, barium and strontium show very analogous behaviour to calcium. The specimen of barium employed had been preserved under oil, and was in the form of a granular powder. It had been prepared from the amalgam and still contained mercury. It was given a preliminary heating *in vacuo* to remove oil and some of the mercury. It commenced to absorb gases without appreciable volatilisation at a temperature notably below that required in the case of calcium. A non-conducting vacuum was usually not obtained before the metal had been allowed to cool. In the work with both barium and strontium the hydrocarbon spectrum, reminiscent of the argon gases, was very frequently observed, and was probably due to traces of the oil in which the metals had been preserved. This spectrum usually appeared when the metal was hot, and disappeared on lowering the temperature, the vacuum becoming non-conducting. Coal-gas was admitted to the heated barium to a pressure of 2 to 3 mm., and was rapidly absorbed, and a non-conducting vacuum obtained without difficulty. Air introduced to about 7 mm. pressure was rapidly absorbed, except for argon, exactly as with calcium.

Barium *can* be heated to its absorbing temperature in a hard glass tube by a Bunsen burner, but the tube collapses and cracks on cooling. Under similar circumstances calcium requires a blowpipe to induce volatilisation and absorption, and the tube is completely melted and flows round the calcium in the process.

Experiments with strontium were less complete on account of the difficulty of obtaining the real metal, and on account of the small quantities that had to be used. The first sample bought as strontium proved to be potassium amalgam simply, without sufficient strontium to give a precipitate with sulphuric acid. The metal, when it was obtained, proved to be similar in properties to barium and calcium. On account of the cost only a decigramme at a time could be used, and it is very probable that its behaviour, as observed, was partly due to presence of alkali metals, oil, and mercury, and that electrolytic strontium in compact form, free from these contaminations, would exhibit a behaviour even more nearly allied to calcium. So far it has not been possible to procure this. Absorption with the sample employed seemed to start at a slightly higher temperature than with calcium, and at a high temperature some volatilisation of the metal appeared to occur. This was due probably to a trace of alkali metal. It showed to a very marked extent the phenomenon of not giving a good vacuum until it had been cooled down, and of showing hydrocarbon spectra very strongly, but this behaviour might not be shown by an oil-free specimen. It seemed hardly worth while to pursue experiments with a metal at once so costly and so impure, when a commercial process has been patented for producing the metal on a scale similar to that of calcium. But the experiments proved that, like barium and calcium, it can absorb coal-gas and air, and give a non-conducting vacuum without difficulty.

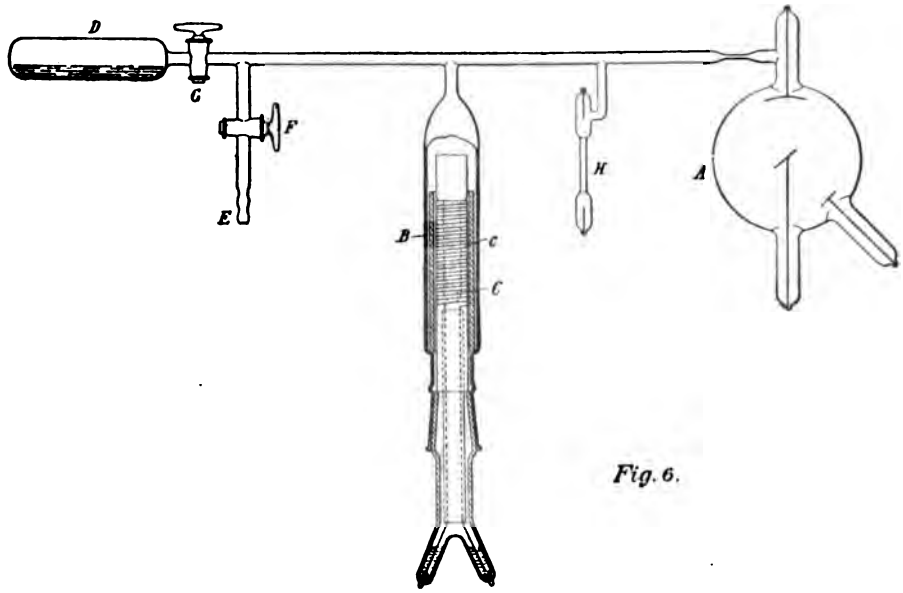


Fig. 6.

VI. *Production of High Vacua by Means of Calcium.*

From what has been said it will be seen that the apparatus described affords a ready means of obtaining a high vacuum by the use of calcium as an absorbent. Arndt, in the paper referred to, suggested its use in the production of high vacua, on account of the energetic action of the vapour on the residual air. A little consideration, however, shows that since argon is not absorbed by the reagent, air must be as rigorously as possible excluded. As is well known, the real difficulty in the production of high vacua depends not so much on the removal of all the original air, which is comparatively easily and quickly accomplished even with a pump, but on the effective removal of the gases which are condensed on the glass walls of the vessel being exhausted, and which tend to re-condense in the pump when driven out of the vessel, and to introduce a kind of steady vapour pressure until they have all been removed. The value of calcium

* Read before the Royal Society, November 15th, 1906

as a means of producing the highest vacua depends on its power to absorb almost instantly the gases condensed on the glass walls as soon as the latter are expelled by heating. It is, as stated, necessary to replace all the air in the apparatus before the absorption with calcium takes place, or the residual argon will prevent the vacuum obtained from being really good. The importance of this is increased by the fact that articles for exhaustion have usually to be provided with a very constricted orifice, so that they can be sealed safely after the vacuum has been obtained. As a consequence, any argon accumulating in the absorption chamber dams back the flow of absorbable gas from the vessel being exhausted, and enormously increases the time required, as the contents of the vessels have to diffuse and mix through the constricted orifice, and this process may require some minutes. Hence, in this method of high vacua production, the customary precautions must be taken against the leakage of air, if really high vacua, as distinguished from the apparently high vacua later to be considered, are desired.

Fig. 7.

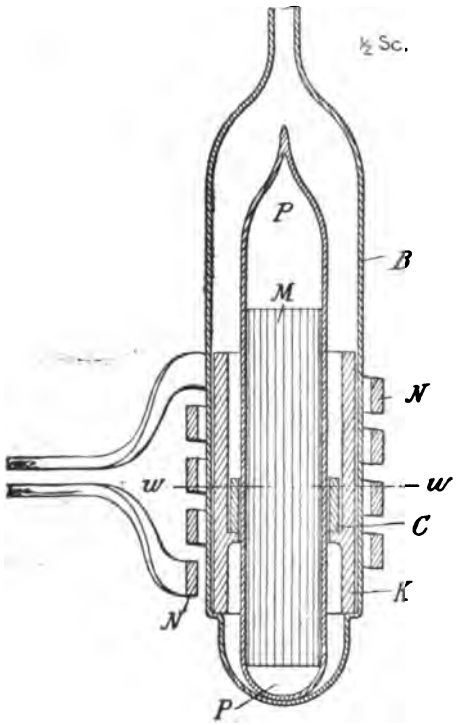
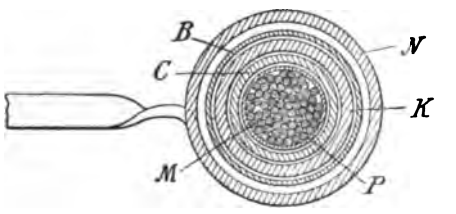


Fig. 8.



If a Fleuss pump in good order is available, and new glass apparatus which has not before been exhausted is being dealt with, it suffices to continue the pumping while the apparatus in question is heated in the usual way to expel condensed gases, and so utilise the latter to replace the residual air remaining in the apparatus. Or, if a new charge of calcium, not previously heated in a vacuum, is employed, the same displacement of the air can be readily effected by the gases given out by the calcium before it attains its absorption temperature. In both cases the gases consist chiefly of carbon and hydrogen compounds, and, being free from argon, serve well for the displacement of the remaining air. In other cases, or where more certainty is desirable, the complete replacement of the air may be effected by the use of a side tube containing a mixture of potassium chlorate and manganese dioxide, which evolves oxygen on warming. One or two small quantities of oxygen are admitted during the pumping, and the connection with the pump closed or sealed off before the calcium is brought into action. Fig. 6 shows, in diagram, an apparatus suited for the purpose of exhausting an X-ray bulb. C is the calcium heated by the platinum wire *c* within the glass vessel B. A is an X-ray tube, and D is a tube containing the oxygen mixture. The Fleuss pump is connected with E, and the spectrum tube H is a convenience both for judging of the degree of vacuum and the character of the residual gas.

With this method, as in all methods of vacua production, the degree of rarefaction attained is the balance between the rate of absorption or removal of the gas present, and the rate of supply of fresh gas from leaks or from condensed films, or from substances such as lubricating grease or mercury which have a vapour pressure. Since the rate of absorption is extremely rapid good results can be obtained even under poor conditions. Conditions have to be very bad indeed for any difficulty to be experienced in the production of a so-called "X-ray" or "non-conducting" vacuum. But it will be shown in the sequel that these electric discharge phenomena may be produced in vacua which could not be described as high in any other sense. With proper care the very highest vacua may be obtained by the use of calcium, as is proved by the experiment quoted in Section IV, of filling the apparatus with mercury and compressing the gaseous contents several hundred times. Personally, in crucial experiments, I should use it preferably to any other, and in the research on the positive charge carried by the α-particle it was the final court of appeal, by which results obtained by other methods were always re-tried (*Nature*, August 2, 1906, p. 316).

VII. *An Induction Method of Electrically Heated Calcium in Glass Vessels.*

Calcium is an excellent conductor of electricity, being the fifth best if wires of equal length and diameter (Ag, Cu, Au, Al, Ca), and the third best if wires of equal length and weight (Na, Li, Ca, Mg, K, Al) are compared. Its volatility, relatively low melting-point, and low resistance are all against the possibility of heating calcium to its absorbing temperature by conducting a current through it. But in the form of fairly massive discs or rings calcium may be heated to its melting-point by induction through the glass walls of the containing vessel by means of alternating circuits outside the vessel. For instance, if a bundle of iron wires, similar to the core of an induction coil, is put through a ring turned out of a bar of calcium, and the whole placed in an exhausted glass tube, the walls of which are protected from fusion by a porcelain shield-tube in the manner before described, and a bobbin of insulated wire traversed by an alternating current of high periodicity be slipped over the glass tube, the calcium may be readily heated to its absorption and volatilisation temperature. The arrangement is simply a step-down transformer, in which the calcium ring acts as the single short-circuited winding of the secondary, and being of low resistance a fraction of a volt induced in it by the magnetic flux suffices to cause the passage of a heavy current, probably of the order of a kilo-ampère, which heats it to the required high temperature. Fig. 7 shows one arrangement for this purpose.

Fig. 8 is a transverse section on the line *ww*. The iron core M is enclosed in a thin tube of Jena glass P, which is exhausted and sealed. This tube effects the double purpose of protecting the iron from excessive heat and retaining gases given off from the iron, but can be dispensed with. C is the calcium ring, K is the porcelain shield-tube, B is the outer glass containing tube, N is the external circuit through which the inducing current is passed. As the heat given out from the calcium is considerable and apt to injure insulating material, it is convenient to employ, instead of a bobbin of insulated wire of many turns, a few turns of stout, bare, copper bar or tube, and to obtain the inducing current from the secondary of a step-down transformer not shown in the drawing. Since the magnetic flux, and therefore the inducing voltage in C, varies as the square of the diameter of the core, while the resistance of C varies as the diameter, it follows that the larger the diameter of cross-section of the apparatus the easier it is to obtain the desired result. But the induced voltage depends also on the periodicity of the inducing current, so that the latter must be the higher the smaller the apparatus employed. The dynamo employed was specially constructed for the purpose, and gave with variation of speed a periodicity from 200 to 400 cycles per second. The drawing shows the apparatus to the scale of 6 inches to the foot.

Another form of apparatus is shown in Fig. 9, to the scale of 3 inches to the foot. It differs from the last mainly in that the magnetic circuit, composed of the iron strips or wires M_2 M M M_2, is closed, but for the two air gaps where the glass walls of the containing vessel penetrate it. The use of the step-down transformer is unnecessary, because the inducing bobbins, represented diagrammatically by the circuit N N N N, are far enough removed from the source of heat not to be damaged. The part within the glass containing vessel is shown to twice the scale (6 inches to the foot) in Fig. 10. Fig. 11 is a section of the same. Figs. 12 and 13 are transverse sections in vertical and horizontal planes respectively. C is a disc of calcium bored with a central hole through which passes the bundle of iron wires M M. P_2 P_2 are two porcelain crucible lids bored with central holes. Instead of the disc of calcium shown, a disc one-third the thickness between two similar discs of copper may be employed if it is required to increase the conductivity. Since in these induction methods of heating the heat is developed in the reagent itself, the latter is hotter than its surroundings, which is a great advantage, as far less screening of the glass walls suffices. The temperature of the metal can be very accurately judged by the eye, and must be kept below the melting-point. A moderate red-heat just above the cherry-red stage is necessary for absorption of gases and volatilisation to occur.

Fig. 9.

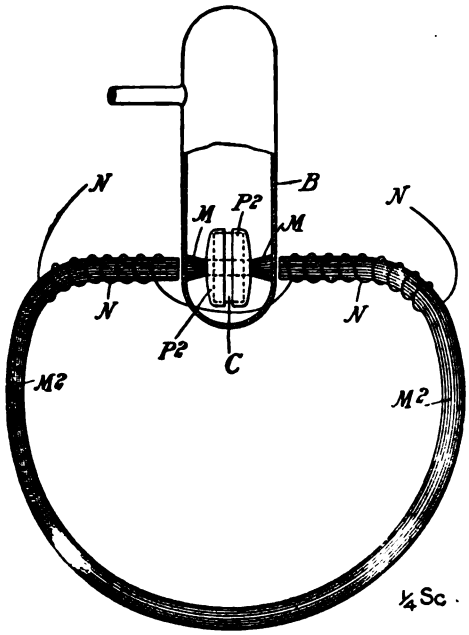


Fig. 10.

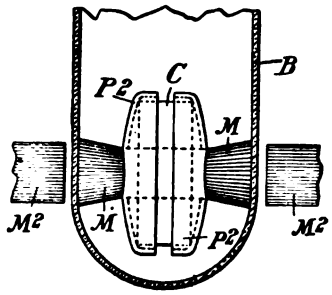


Fig. 12

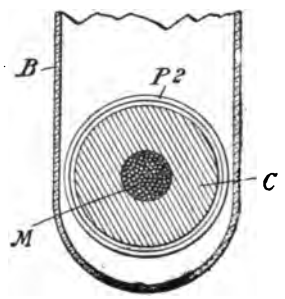


Fig. 11.

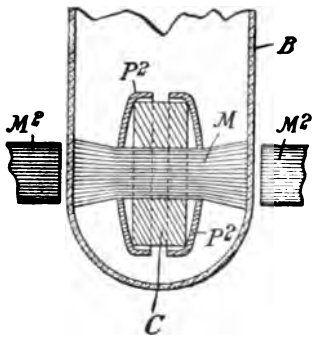
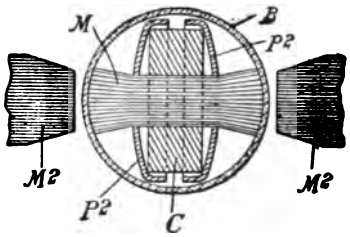


Fig. 13.



For experimental work where cost is not the primary consideration, and where frequent dismantling of the apparatus is rendered necessary, the resistance furnace method of heating is to be preferred. But for prolonged work in which the object is simply to obtain a high vacuum, the induction method offers great advantages.

VIII. *Some Practical Considerations in the use of Calcium as an Absorbent for the Production of High Vacua.*

There is no doubt that a low initial pressure, not exceeding a few millimetres of mercury, is as essential a condition in causing calcium to combine with gases as a high temperature. As Arndt showed, there is a slight initial absorption below the volatilisation temperature, and this is of great practical importance. For rapid and continuous absorption volatilisation is essential. But in a case where the initial pressure is above that at which volatilisation occurs, the slight initial action is often sufficient to lower the pressure to the extent necessary for the formation of vapour. When this has once taken place subsequent absorption is much facilitated, for the film of volatilised metal continues, even in the cold, to absorb, although more

slowly than the vapour itself. Hence, once volatilisation has taken place there is present a tendency to re-establish the condition for further vaporisation. When, however, a mixture with an unabsorbable constituent, for example, air, is being absorbed, the accumulation of this constituent hinders the volatilisation and further absorption by the calcium. Another factor operating in the same direction is the increased loss of heat by convection currents in the presence of a gas, tending to lower the temperature of the reagent and furnace, and to lower the resistance of the latter. In the usual case, where this resistance is small compared to the external resistance in the circuit, the fraction of the electrical energy dissipated within the furnace is also lowered, and so the temperature falls from a double cause. If water vapour is present the action becomes extremely marked on account of the great conductivity of this vapour to heat. The current necessary to raise the temperature in this case may be so great, that unless promptly reduced when absorption commences the heating circuit is apt to be destroyed.

Under proper conditions of working the calcium should never be melted, although it may be volatilised completely and re-deposited on the cooler part of the tube as a compact tube or ring difficult to remove by mechanical means. Used porcelain tubes should never be exposed to the air or treated with water or dilute acids, as they readily crack under this treatment. Immersion in concentrated hydrochloric acid usually serves to dissolve the volatilised metal without cracking the tube, but with the liberation of the spontaneously inflammable silicon hydride. If the calcium is melted in the tube the latter usually cracks on cooling, so that for many reasons suitable iron tubes would be better than porcelain. The narrow margin of temperature, 70° C. according to Arndt, between the volatilisation and melting-point need, however, never be exceeded when experience has been gained and suitable metal is employed. The presence of hydride in the metal acts so prejudicially, largely because the dissociation tension of hydrogen lessens the volatilisation and reduces still further this narrow margin, so that the melting-point is the more likely to be overstepped. These conclusions as to the conditions under which calcium should be employed as an absorbent have been arrived at after over a year's continuous use of the method.

The following experiment on the effect of vapour of grease and of a very constricted orifice between the vessel being exhausted and the absorption chamber is instructive. An X-ray bulb was connected to the calcium absorption apparatus provided with a ground-joint. The latter was lubricated by the well-known mixture of rubber, paraffin-wax, and vaseline, employed by Sir W. Ramsay. A spectrum-tube was provided and the apparatus exhausted by the Fleuss pump, and the connection with the latter sealed off. The calcium was brought into action and a vacuum corresponding to an alternative spark-gap of 15 cm. obtained in the X-ray tube. It was then left over night in connection with the furnace, so that the vapour from the grease of the ground-joint could exert its full effect. In the morning the vacuum was so low that there was no trace of green fluorescence in the tube. The calcium was heated and allowed to cool. In forty minutes the 15 cm. alternative spark-gap was again attained.

Then, hour by hour, the vacuum slowly deteriorated till the alternative spark-gap was *nil* and the green fluorescence disappeared. This process of heating the calcium and leaving till the vacuum went right down was repeated day by day for a week. It was noticed that it always took forty minutes after heating the calcium before the 15 cm. spark-gap was regained, and this period represented, as numerous experiments with the same tube show, the time taken by the gases to flow out of the X-ray bulb through the constricted orifice when a practically perfect vacuum existed on the other side. It happened that the constriction was unusually and unnecessarily narrow, such as an amateur not realising the importance of it would make, but the necessity of this constriction, where the tube is ultimately to be sealed off, imposes a natural limit on the time taken for the exhaustion, however rapid a method of absorption is employed. In this experiment the spectrum in the Plücker tube, when the vacuum was low, was due to hydrocarbons, and nitrogen was never seen. That there was no appreciable leak of air was also shown by the fact that even at the end of a week no lines of argon could be seen. This shows that the deterioration of the vacuum was simply due to vapour being slowly given off from the grease used for lubrication. A properly constructed ground-joint is wonderfully air-tight. I may mention that in 1904 I constructed one of Strutt's so-called radium clocks with a ground-joint similar to those employed in the furnaces. The period of the clock is the same now as when constructed, and it has worked continuously without re-exhaustion, proving conclusively that no trace of air has leaked through the ground-joint. Hence, in the calcium method, where the vapours of lubricants are absorbed with rapidity, as many taps, ground-joints, and similar conveniences as desired may be employed without harm, provided they are well lubricated and never get heated, and that the apparatus being exhausted is sealed off as soon as the high vacuum is attained.

(To be continued).

THE APPLICATION OF THE ELECTRON THEORY TO ELECTROLYSIS.*

By E. E. FOURNIER-D'ALBE.

The electron theory of electricity and magnetism may be fitly described as an extension of the ionic theory of electrochemistry to solids, gases, and a vacuum, inasmuch as it postulates material carriers of all electric charges, and reduces electric phenomena to the configuration and motion of these carriers. The application of the electron theory to electrolysis means, therefore, no revolutionary change in electrochemical conceptions, but simply an attempt to bring our extended knowledge of the properties of the elementary carriers of electricity to bear upon well-known phenomena, and thus to gain a clearer insight into the actual mechanism of electrolytic conduction and dissociation.

One of the most valuable achievements of the electron theory is the complete harmonisation of the processes of metallic and electrolytic conduction. Both processes depend upon the existence of minute charged bodies capable of threading their way through a mass of other bodies which are either uncharged or less mobile. If a body contains no such charged bodies—ions in the wider tense—or if its ions are fixed in position, it is incapable of conveying an electric current of any description. A current consists in the displacement of ions. The conductivity of a body is accurately and precisely defined by the number of ions it contains in unit volume and by their average mobility; this mobility, in its usual acceptation, excluding any measurable free path. The definition and physical interpretation of conductivity is thus the same in liquids and solids.

It is only when we consider the individual carriers themselves that a fundamental difference appears between metallic and electrolytic conduction. Compare a cm.-cube of copper with a cm.-cube of dilute hydrochloric acid, each of them conveying a current of one ampère. The copper conveys its current almost solely by its free electrons, some 400 million in number, which possess a mobility some 100 million times greater than that of a hydrogen ion. The hydrochloric acid conveys the current by means of its hydrogen and chlorine ions, which, in a millinormal solution, amount to about 2 million. Since the current is the same in each case, the electrons in the copper must move

* Abstract of a Paper read before the Faraday Society, January 15, 1907.

some two hundred times more slowly than in the electrolyte. But this is not usually the case, for in a copper wire 1 mm. in diameter conveying one ampère the speed of the electrons is of the order of 1 cm. per second. The greatly superior mobility of the free electrons brings it about that a much lower voltage is required to maintain an ampère in a copper conductor than in a liquid conductor of the same dimensions.

Whence this difference between solids and liquids? At first sight it seems strange that free electrons should be observable in a vacuum and traceable in a metal, but that there should be none in a liquid. The elucidation of this question would be of fundamental importance for the theory of electrolysis, and would constitute a valuable contribution from the general theory to the special field to which, as a matter of fact, it owes its origin.

It cannot be said that this question is anywhere near a complete solution. But since the whole range of electromagnetic phenomena has become unified under the sway of the electron theory, much additional material has become available upon which to base our judgment.

The existence of free electrons in metals is made possible by the close packing of their atoms, which brings about a frequent exchange of electrons between one atom and another. During the short period occupied by its change of allegiance—a period amounting to something like 1/5000th of its average time of attachment to a metallic atom—the electron is free to fall along the potential gradient, and thus to constitute an electric current. When the metal expands by heat, this process of exchange naturally becomes rarer, and the metallic resistance increases. The positive atoms and neutral atoms are so tightly packed that they contribute nothing perceptible to the conductivity.

In an insulating solid or liquid the electrons are effectively bound up with atoms or molecular groups, and these are arranged in some structure, usually crystalline in the case of solids, which precludes the formation of mobile charged groups and the liberation of electrons.

In an electrolyte, on the other hand, such charged groups are formed, and they are sufficiently mobile to follow the E.M.F. That free electrons are not produced is capable of a simple explanation. Two copper atoms have equal attonitions for an electron, but atoms of, say, hydrogen and chlorine have not. Hydrogen loses one of its electrons more easily than chlorine, and when the two atoms of a molecule of hydrochloric acid separate, the chlorine takes one of the normal hydrogen electrons away with it. The hydrogen atom thus remains positively charged, and the chlorine atom negatively. The two ions so produced act as condensation nuclei, like any other small charged particles. The study of electric condensation nuclei will, I believe, shed a flood of light on electrolytic problems. The fundamental researches of C. T. R. Wilson have proved that in vapours, at all events, ions act as condensation nuclei, and that negative ions are slightly more effective than positive ions (*Phil. Trans.*, 1897, clxxxix., p. 265). Of this phenomenon J. J. Thomson has furnished a simple explanation ("Conduction of Electricity through Gases," 2nd ed., p. 179).

When a charged drop evaporates its electric charge remains, and its potential increases as its diameter diminishes. More energy is therefore required to evaporate a charged drop than an uncharged drop. Condensation on the drop involves an expenditure of available electric energy, and thus condensation is facilitated. This fact has an important bearing on the theory of electrolysis. It explains the low mobility of the ions, the drop of potential at the electrodes, and the liberation of uncharged products at the latter. The different mobilities of the ions can, I think, only be attributed to their different degrees of normal hydration. That hydroxyl should have a mobility over four times that of lithium points to the lithium atom as a particularly efficient condensation nucleus when deprived of one electron. It moves so slowly through the water under the influence of the potential gradient, because it has to drag a number of water molecules (probably not more than half a dozen) along with it. The number must be the same for each ion at a given temperature, but cannot be very large, to judge from the actual mobility (347×10^{-4}) compared with that of the electron in copper (about 5×10^{4}).

When these hydrated ions reach the electrodes the E.M.F. tends to drive them into the metal of the electrodes. But the atoms of the latter are so closely packed, as a rule, that no other atoms can force themselves between them. There arises a deadlock, which is only released when electrons are able to pass from the solution into the metal, or *vice versâ*. The mobility of electrons, though comparatively great inside a metal, is very small at its surface, where the close packing of the metallic atoms loses its effect. But when the E.M.F. exceeds a certain minimum an electron may pass, say, into a hydrogen ion, and neutralise its positive charge. The immediate consequence will be that the hydrogen loses its condensing power. The link between it and the water molecules is broken, and the hydrogen is liberated as an uncharged gas. The converse process goes on at the anode. The chlorine atom passes its superfluous electron into the anode, thereby becoming neutral and free from its aqueous encumbrance.

In the further theoretical investigation of electrolytic action on the basis of the electron theory the study of mobilities will have to play a prominent part. Bredig's laws of mobility are of special interest in this connection. We require a quantitative determination of the hydration of the ions. This determination should not be very difficult, since a number of data, such as heats of solution, melting and boiling-points, are ready to hand. It should be possible to determine the diameter and bulk of the ions, and their shape from stereochemical considerations. The fact, noted by Bredig, that the strongly electropositive and electronegative metals have a high mobility points to a superior facility of reaction.

A high mobility implies a low degree of hydration of the ion. This low degree of hydration enables such ions, when of opposite signs, to combine more freely and rapidly than is the case in ions having a larger bulk. The heats of reaction, the heats of ionisation, and the electro-affinities or electrode potentials of the majority of elements are fairly well known, and afford valuable data for determining the sizes of the ions. We already know that isomeric and metameric ions have the same mobility; that the mobility of an ion of a given sign is the smaller the greater the number of atoms it contains; and that the effect of any change in the constitution of an ion is the greater the smaller the number of atoms contained in the ion.

These facts leave the road clear for a determination of the actual constitution of a single ion on kinetic principles. When an iron contains 50 or 60 atoms it appears to have a minimum mobility which is not preceptibly diminished by a further addition of atoms. Such an ion must have a diameter of about a micromillimetre, and therefore comes within the range of Szigmondy's ultramicroscope. There is, therefore, a possibility that the motion of such heavy ions may be studied by actual observation, and that they may be watched as they cover a distance of 1 cm. in an hour and a half under the influence of a potential gradient of 1 volt per cm. It then becomes a comparatively simple calculation to find the diameter of such an approximately spherical ion moving through a viscous liquid, or, in the last resort, threading its way among molecules of perhaps half its diameter. Such calculations have been made in connection with metallic conduction, and have led to the conclusion that the carriers of the current in a wire are almost solely the free electrons.

A difficulty is presented by the circumstance that ions of the higher valencies exhibit mobilities which are neither "independent" nor constant for different concentrations (see Kohlrausch and Grüneisen, *Sitzungsber. Berlin Akad.*, xl., July 28, 1904). The extraordinarily high mobility of lead is not easily harmonised with our notions of the physical constitution of the ions. But it is interesting to

note that the influence of hydration increases with the valency and the concentration, which is what we should expect.

The future development of electrolytic theory will lie, I think, in the direction of statistical analysis on kinetic principles. Such analyses have yielded most suggestive results in gas discharges, more especially the electric arc, in the vacuum tube, the Zeeman phenomenon, and, quite recently, in metallic conduction. Thomson's famous "counting experiment" must be followed up. He produced ions in a moist gas, and watched them as they settled down under the influence of gravity. We must follow their motions along the potential gradient in a liquid, and follow the fate of the electrons they convey through the liquid into one electrode, and back into the liquid through the other. The complete determination of the energy absorbed or emitted at the various stages of this transmission means the complete mastery of the problems of electrolysis.

THE NITRATION OF ANILINE AND CERTAIN OF ITS DERIVATIVES.

By J. BISHOP TINGLE, Ph.D., F.C.S., and F. C. BLANCK.

It is well known that aniline cannot be directly nitrated; under any of the ordinary conditions in which such action might be expected to take place, nitric acid converts aniline into a resinous, tarry, or charred mass. This behaviour is usually accounted for by stating that the nitric acid attacks the amino group more readily than the benzene nucleus (*vide*, for example, Lassar-Cohn's "Application of some General Organic Reactions," translated by J. Bishop Tingle, p. 3, *et seq.*). A little thought will show that such a statement, although it *may* be true, is really devoid of any experimental foundation, and that certain rather serious objections could be urged against it. For instance, it has been suggested by some chemists that substitution in the nucleus is really preceded by the substitution in the side chain, and subsequent re-arrangement. Further, the amino group is even more sensitive towards nitrous acid than towards nitric acid, as is shown by the fact that, in general, nitrites of the aromatic amines cannot be prepared, whereas the nitrates are usually stable; moreover, in carrying out the diazo reaction, some tarry matter is always formed, and unless considerable care is taken to adjust the conditions of the experiment specially for each individual amine, this tar is apt to be the chief, or even the only tangible product of the reaction.

Guided by these considerations, we decided to re-investigate the direct nitration of aniline, and to begin a systematic survey of the influence, on nitration, of the substitution in aniline of one or both of the hydrogen atoms of the amino group. Coupled with this, however, is the further question of the influence exercised on the substitution by admixture of the nitric acid with other acids. These points are illustrated by the fact that dimethylaniline yields the paranitro derivative when nitrated in the presence of acetic acid (*Ber.*, x., 761), whereas the meta compound is formed if sulphuric and nitric acids be used (*Ber.*, xix., 198). A number of cases are on record where mixtures of nitric and acetic acids *or* nitric and sulphuric acids have been employed to nitrate some compound, but this is the only example which we have been able to find in the literature of nitration experiments having been made on a given aniline derivative with each of these mixtures of acids. The influence of the substituting group is shown by the fact that formanilide, for example, yields the paranitro derivative by direct nitration (*Am. Chem. Journ.*, viii., 346), whereas, under the same conditions, acetanilide gives rise to a mixture of ortho and paranitro compounds (*Jahresb.*, 1875, p. 344; *Am. Chem. Journ.*, xi., 320).

The investigation just outlined will, naturally, extend over a considerable time, and we wish to reserve the field by the publication of this paper, which, although it is of a preliminary nature, contains results that we think may prove to be of some general interest.

Nitration of Aniline.—Our experiments in this connection being based upon the hypothesis that nitrous acid might probably be the active agent in producing the decomposition of the aniline, we took every precaution in our power to exclude this substance, and to remove it if it were formed. Accordingly, the nitric acid which was used was freed from dissolved oxides by means of a current of dry air, and, as far as possible, oxidation during the experiment was avoided by employing nitric acid of 99 per cent concentration and freshly distilled aniline. We carried out the experiments in platinum vessels, placed in a freezing mixture, so as to keep the temperature as low as possible, and took care that the reagents were gradually mixed and thoroughly stirred; moreover, we operated in the presence of urea, in the hope that any nitrous acid which might be produced by the possible reduction of some of the nitric acid would be instantly decomposed by this reagent. In the later experiments we employed aniline nitrate in place of aniline, so as to eliminate the heat of formation of this salt. In every experiment, however, it was found to be impossible to keep the temperature sufficiently low, and, as soon as it rose, tarry or carbonaceous products were formed. The result was identical whether the acid was added to the aniline or *vice versâ*.

These experiments were therefore discontinued and another series undertaken in order to determine at what concentration of nitric acid the formation of aniline nitrate ceases and nitration—or charring—begins. The results demonstrated that any strength of acid could be used up to at least 75·33 per cent HNO_3, provided, in the case of the more concentrated acids, above 50 per cent, that the mixture was cooled and excess of acid was avoided. Acids of 50·71 to 75·33 per cent always gave, with aniline, a pink-coloured solid, which was stable at 0°; the colour was at once discharged by the addition of a little water or of a few drops of aniline. Slight excess of acid increased or restored the colour, as the case might be, but if this additional acid was of sufficient concentration, then, sooner or later, depending on this concentration and on the temperature, the pink colour darkened, finally becoming black, and the whole mass gradually charred, sometimes becoming incandescent. We have been unable to find any previous record of these phenomena.

With acid above 75·33 per cent HNO_3, charring took place rather quickly, although the aniline was in considerable excess. We believe, however, that this was due to the impossibility of preventing local superheating; *i.e.*, to the action of the concentrated acid, at a relatively high temperature, on aniline nitrate. Be this as it may, it is certain that with acids containing up to 75·33 per cent HNO_3, any charring which may be brought about is due to an attack on aniline nitrate and not to one on free aniline. We emphasise this rather obvious fact in order to contrast it with the behaviour of aniline towards a mixture of nitric and sulphuric acids, in which the latter is in considerable excess. In these circumstances, as is well known, nitration proceeds smoothly, because, as it is usually expressed, the sulphuric acid "protects" the amino group. Surely, however, the amino group is equally well "protected" in the nitrate, $C_6H_5NH_3NO_3$, as in the sulphate, $C_6H_5NH_3SO_4H$, and the excess of concentrated sulphuric acid which is present must abstract so much water from the nitric acid as to make it of a higher concentration than 75·33 per cent HNO_3. The only very obvious difference in the conditions of the two experiments, so far as we can see, is in that which governs the temperature. In the experiment with sulphuric acid all the materials are in solution, and the "heat of nitration," as it may be termed, is instantaneously absorbed and diffused throughout the large volume of comparatively indifferent sulphuric acid, whereas in our experiments with aniline nitrate and nitric acid we had to rely on the relatively slow, inefficient, and clumsy mechanical means of stirring

and external cooling to neutralise this heat. We hope, later, to recur to this point, when more experimental data have been accumulated.

Nitration of Aniline Substituted in the Amino Group.—A considerable amount of scattered work, which will be cited in due course, has been done on the nitration of compounds of the types C_6H_5NHR, C_6H_5NRR' and $C_6H_5N{:}R''$, and in some of these experiments the nitric acid was mixed with sulphuric or acetic acids. This portion of our investigation has been carried out with the following reagents:—1. Nitric acid, sp. gr. = 1·46, containing 80 per cent HNO_3 (Remsen and Graham, *Am. Chem. Journ.*, xi., 320). 2. Nitric acid, sp. gr. = 1·46, with glacial acetic acid, usually in the proportion 1·25 mols. of nitric acid to 4 mols. of acetic acid, or 1·25 mols. of nitric acid to 8 mols. of acetic acid. 3. Nitric acid, sp. gr. = 1·46, and anhydrous oxalic acid, in the proportion 1·25 mols. of nitric acid to 4 mols. of oxalic acid. 4. Nitric acid, sp. gr. = 1·46, and trichloracetic acid, in the proportion 1·25 mols. of nitric acid to 4 mols. of trichloracetic acid, 5. Nitric acid, sp. gr. = 1·46, and concentrated sulphuric acid, sp. gr. = 1·83, containing about 92 per cent H_2SO_4. in the proportion of 1·25 mols. nitric acid to 4 mols. of sulphuric acid. The dissociation constants of these admixed acids are as follows:—Acetic acid, K = 0·0018; oxalic acid, K = 10·00; trichloracetic acid, K = 121·00; sulphuric acid, K = 130·0, approximately, by calculation. It will be observed that we have selected, for admixture with the nitric acid, acids of widely differing strength. Acetic is a typical "weak" acid; trichloracetic is, practically, the strongest organic acid which is known, and certainly the strongest which is available for use in any quantity. Oxalic acid was selected partly because it is dibasic, but chiefly because of its intermediate position between the other two. The use of sulphuric acid was dictated by the fact that it is the only "strong" inorganic acid suited for the purpose in view. It will be noticed that, in so far as "strength" is concerned, sulphuric and trichloracetic acids are in the same class (*cf.* Kastle, *Am. Chem. Journ.*, 1905, xxxiii., 52), and should therefore permit of a conclusion being drawn as to the influence, if any, of the mono or dibasicity of the admixed acid, and of its organic or inorganic composition, *i.e.*, as to the possible specific influence of a carboxyl group.

As far as possible, we desired to avoid the formation of di- or polynitro derivatives; consequently, our experiments were usually carried out at room temperature; in cases where there was a considerable evolution of heat on mixing the substances, cooling with ice-water was resorted to. Sometimes the mixtures were surrounded by crushed ice during the whole time of an experiment, and occasionally gentle warming was requisite to promote a reaction.

Formanilide.—This substance yields paranitroformanilide by direct nitration (*Am. Chem. Journ.*, viii., 346). In the presence of sulphuric acid we have obtained the *meta derivative*.

Acetanilide.—This compound, by direct nitration, gives a mixture of ortho and para derivatives (*Jahres.*, 1875, p. 344; *Am. Chem. Journ.*, xi., 320). In the presence of acetic acid no nitration took place under the conditions of our experiments. With oxalic acid we obtained *paranitroacetanilide* in good yield. The same result was produced by the use of trichloracetic acid, which was ground up with the acetanilide, and the mixture added to the nitric acid. Sulphuric acid yielded *metanitroacetanilide*. This last result differs from the experience of Nölting and Collin, (*Ber.*, xvii., 261), who, however, operated in a freezing mixture of ice and salt, and, nitrating in the presence of both acetic and sulphuric acids, obtained the para and ortho derivatives.

Benzoylanilide.—A mixture of ortho, meta, and paranitro derivatives is formed by the direct nitration of this compound (*Liebig's Ann. Chem.*, ccviii., 292). Operating in the presence of sulphuric acid we have only found the *para compound*.

By the use of acetic acid we have obtained the *meta isomer*, practically without admixture.

Methylaniline.—Our experiments with this substance, in the presence of acetic acid, failed to yield any positive result. Sulphuric acid causes the production of the meta-nitro derivative (*Centralbl.*, 1901, i., p. 105.

Ethylaniline.—This body behaved, with acetic acid, like the methyl compound. In the presence of sulphuric acid meta and para derivatives are formed (*Ber.*, xix., 546).

Dimethylaniline.—For the sake of completeness we include this substance, although we have no results of our own to communicate at present. Acetic acid is stated to produce the paranitro derivative (*Ber.*, x., 761), whereas sulphuric acid gives rise to the meta compound (*Ber.*, xix., 198).

Diethylaniline.—In our experiments with this substance, in the presence of acetic acid, nitration failed to take place. Sulphuric acid has been found to produce chiefly the meta derivative, together with some para compound (*Ber.*, xix., 199).

We think that our results justify the statement that *the position assumed by the entrant nitro group is definitely influenced both by the acid present with the nitric and also by the* N-*substituents*.

We hope to give full details of our experiments later, when the work on the subject, which is now in progress in the Johns Hopkins laboratory, is more nearly complete. —*American Chemical Journal*, xxxvi., No. 6.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting December 20th, 1906.

Prof. R. Meldola, F.R.S., President, in the Chair.

(Concluded from p. 22).

226. "*Some Derivatives of Salicylic Acid.*" By Hooper Albert Dickinson and Frank Lee Pyman.

In the course of the production of some derivatives of salicylic acid which might possibly find application in medicine, *cinnamoylsalicylic acid*, its *methyl* and *ethyl esters*, and *quinine salt*, and also 3 : 5-*dichloroacetylsalicylic acid* were prepared and characterised.

Cinnamoylsalicylic acid, $CO_2H{\cdot}C_6H_4{\cdot}O{\cdot}CO{\cdot}CH{:}CHPh$. Ten grms. of salicylic acid and 12 grms. of cinnamoyl chloride were heated together on a water-bath during three and a-half hours. The end of the reaction was indicated by the mixture becoming quite solid. After two re-crystallisations from benzene, *cinnamoylsalicylic acid* was obtained in a pure state, and in quantity amounting to 48 per cent of the theoretical yield; it crystallises from benzene in needles melting at 155°; is very readily soluble in alcohol or ether, sparingly so in chloroform or benzene, and almost insoluble in water:—

0·2409 gave 0·6316 CO_2 and 0·0981 H_2O. C = 71·5, H = 4·5.
$C_{16}H_{12}O_4$ requires C = 71·6, H = 4·5 per cent.

The *quinine salt*, $C_{16}H_{12}O_4,C_{20}H_{24}O_2N_2$, crystallises from alcohol in needles which melt at 169°. It is almost insoluble in water or cold alcohol:—

0·2151 gave 0·5729 CO_2 and 0·1208 H_2O. C = 72·5, H = 6·2.
$C_{16}H_{12}O_4,C_{20}H_{24}O_2N_2$ requires C = 72·9, H = 6·1 per cent.

The *methyl ester* was prepared by the condensation of molecular quantities of cinnamoyl chloride and methyl salicylate by means of anhydrous potassium carbonate. The product was purified by first treating with hot water, dissolving in chloroform, drying this solution, and mixing the oil which resulted after the removal of the solvent with light petroleum. On then re-crystallising from alcohol, the pure ester was obtained in large tabular crystals melting at 71° and in an amount equal to 63 per cent of the theoretical yield:—

0·2320 gave 0·6144 CO_2 and 0·1049 H_2O. C = 72·2, H = 5·0.
$C_{17}H_{14}O_4$ requires C = 72·3, H = 5·0 per cent.

The *ethyl ester*, obtained in an analogous manner, crystallises from alcohol in fine needles melting at 66—67°:

0·2433 gave 0·6476 CO_2 and 0·1182 H_2O. C = 72·6, H = 5·4.
$C_{18}H_{16}O_4$ requires C = 72·9, H = 5·4 per cent.

3 : 5-*Dichloroacetylsalicylic acid*, $C_9H_6O_4Cl_2$. This substance was prepared by the acetylation of 3 : 5-dichlorosalicylic acid with acetic anhydride and sodium acetate. It crystallises from benzene in needles melting at 159°:—

0·3350 gave 0·5328 CO_2 and 0·0732 H_2O. C = 43·4, H = 2·4.
0·2060 „ 0·2358 AgCl. Cl = 28·3.
$C_9H_6O_4Cl_2$ requires C = 43·4, H = 2·4, Cl = 28·5 per cent.

227. "*The Addition of Bromine to Cinnamic Acid and its Esters.*" (Preliminary Notice). By John Joseph Sudborough and John Thomas.

The appearance of a communication from W. Herz and Bruno Mylius in the last number of the *Berichte* (1906, xxxix., 3816) on the velocity of the addition of bromine to cinnamic acid induces us to give a preliminary account of experiments made by us on the same subject. All our experiments were conducted in pure dry carbon tetrachloride at 15°. The bromine used was the commercial product dried with sulphuric acid. We find that the velocity varies enormously according as the reaction proceeds in the dark or in daylight.

The following numbers calculated by means of the equation for a bimolecular reaction, when molecular proportions of bromine and of cinnamic acid, namely, some 0·0333 mol. per litre, are used, show this clearly.

Cinnamic Acid.—K (in dark). Series 1: 0·0054, 0·0044, 0·0066, 0·010, 0·013. Series 2: 0·0072, 0·0074, 0·0066, 0·012.

K (in diffused daylight). Series 1: 0·28, 0·33, 0·36, 0·33. Series 2: 0·41, 0·37, 0·31, 0·34, 0·30, 0·31.

Similar results have been obtained when the methyl and ethyl esters are used.

Methyl Ester.—K (in dark). Series 1: 0·0058, 0·0060, 0·0058, 0·0089, 0·0089, 0·0081. Series 2: 0·0047, 0·0047, 0·0039, 0·0062, 0·0089, 0·0071. Series 3: 0·0049, 0·0091, 0·0071, 0·0079, 0·0095.

Ethyl Ester.—K (in dark). Series 1: 0·0085, 0·0074, 0·0077, 0·010, 0·011, 0·012. Series 2: 0·0071, 0·0074, 0·0053, 0·0076, 0·012, 0·010. Series 3: 0·0044, 0·0048, 0·0050, 0·0050, 0·0049.

(In diffused daylight) 0·29, 0·25, 0·25, 0·30. (In sunlight) 1·85, 1·70, 1·60, 1·29, 1·62, 1·49.

The velocity constant with crotonic acid is smaller than with cinnamic acid.

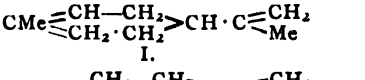
Crotonic acid (in dark) K = 0·00096, 0·00094, 0·00069, 0·00101.

All the experiments were made in glass-stoppered bottles, not in sealed tubes; those conducted in the dark were in amber-brown coloured, the others in colourless bottles.

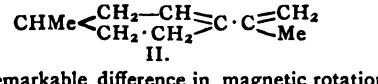
We wish to extend the work in the direction of studying the effect of the introduction of various substituents into the crotonic and cinnamic acid molecules.

228. "*The Optical and Magneto-optical Influence of Ethenoid Linkings Attached to Contiguous Carbon Atoms.*" By Julius Wilhelm Brühl.

It has been found by Sir W. H Perkin that limonene and dipentene (I)., and $\Delta 3 : 8(9)$-*p*-menthadiene (II.)



I.



II.

exhibit a remarkable difference in magnetic rotation, the values of II. being much higher than those of I. The author showed that this is due to the presence of two double linkings in the position —C:C·C:C— in the molecule of $\Delta 3 : 8(9)$-*p*-menthadiene.

229. "*A Difficulty in Theory of Valency of W. Barlow and W. J. Pope.*" By David Leonard Chapman.

In a recent number of the *Transactions* (1906, p. 1675), W. Barlow and W. J. Pope claim to have demonstrated that the doctrine of valency follows as a necessary consequence of certain simple assumptions as to the nature and mode of packing of the atoms. The consequences of the theory have not as yet been fully worked out; for the present, therefore, it will be best to restrict any remarks to an examination of the premisses. An analysis of these has disclosed a difficulty which appears to be of importance and to necessitate some modification of the fundamental assumptions.

In the paper in question the following is laid down as the first geometrical property of spheres:—"If in a close-packed assemblage of spheres, single spheres or groups of two or more, selected homogeneously, are replaced homogeneously by other groups of spheres in such a way that the resulting assemblage is close-packed without resorting to re-marshalling, the replacing group is of practically the same relative magnitude as the group replaced, and possesses the same fundamental valency" (*Trans.*, p. 1724).

A second geometrical property is stated thus:—"If a sphere of volume m (an atom of valency m) is replaced by one of volume $m+n$ (valency $m+n$) one or more additional spheres (atoms) having the total volume n (valency n) must be simultaneously inserted in order that the close-packing may be re-established without re-marshalling" (*Trans.*, p. 1729).

It is declared that from these propositions the law of the equivalence of elements and compound radicles can be immediately deduced, and the fact that an element of fundamental valency m can function as one of valency $m+2n$ is said to receive by means of them a rational explanation.

It will now be shown that different results can be deduced from the propositions in question. Consider a close-packed homogeneous assemblage, the similar parts of which are built up of spheres of the relative volumes—

$$2n_1, 2n_2 \ldots\ldots 2n_n, 2;$$

when n_1, n_2, &c., are whole numbers.

Replace the sphere of volume 2 by two spheres each of volume 1. According to the geometrical property of spheres formulated first above, this can be done without re-marshalling being involved. Now replace one of the spheres of volume 1 by two spheres of respective volumes 2 and 1, and finally replace the two spheres of unit volume by a single sphere of volume 2. The original system has now been converted into one composed of spheres of volumes represented by the numbers—

$$2n_1, 2n_2 \ldots\ldots 2n_n, 2, 2$$

without re-marshalling, and by three substitutions in two of which the first geometrical property and in one of which the second geometrical property have been assumed to hold.

Now we are not concerned with the absolute dimensions of the system, and therefore the initial group of spheres can be regarded as consisting of spheres of the volumes—

$$n_1, n_2 \ldots\ldots n_n, 1,$$

and the final group of spheres can be regarded as consisting of spheres of the volumes—

$$n_1, n_2 \ldots\ldots n_n, 1, 1,$$

the marshalling being the same in both cases.

Therefore two spheres of volume 1 can function as one sphere of volume 1. By similar reasoning it can be shown that a sphere of volume 2 can function as a sphere of volume 1, and in general that a sphere of any size can replace any other without any resort to re-marshalling being necessary.

From the foregoing argument it would appear that the two propositions quoted above cannot be used alone (in their present unqualified form at any rate) to demonstrate

that valency is a simple volume relation. A formal statement, from the authors, of the restrictions to be put upon their use would be of value.

230. "*On the more Exact Determination of the Densities of Crystals.*" By the Earl of Berkeley.

A conical pyknometer with thermometer stopper and graduated side-tube is used, and instead of filling to a mark, the author relies on the evaporation of the liquid (round the neck) to bring the level in the capillary side-tube within the graduations.

The liquid used is carbon tetrachloride, and care is taken that the temperature of the balance case varies but little while the pyknometer is being weighed.

The air adhering to the crystals is expelled by causing a current of carbon tetrachloride vapour to pass over them when in an exhausted vessel, and the pyknometer is filled while still in this vacuous space. A desiccator was described whereby hygroscopic salts may be dried in a current of hot air, and the pyknometer filled in a vacuum. Results for the density of quartz, barytes, and potassium carbonate were given. The maximum difference between any two observations out of eleven on quartz, and out of nine on barytes, is 0·02 per cent. The experiments on potassium carbonate do not agree so closely.

231. "*A Relation between the Volumes of the Atoms of certain Compounds at the Melting-points and their Valencies. Interpretation by Means of the Barlow-Pope Theory.*" By Gervaise Le Bas.

The molecular volumes of complex paraffins and alcohols can be calculated very exactly by means of the formula :—

$$\text{M. V. of } C_nH_{2n+2} = (6n+2)S = 6nS = 2S,$$

where S is a constant which has an average value of 2·970, and is called the unit-stere. It is a measure of the volume of hydrogen. Carbon, in accordance with its valency, is equal to 4S. The value of S is also obtained by dividing the difference for CH_2 by 6. The numbers obtained in this way confirm the previous values.

Certain alcohols up to heptadecyl carbinol, $C_{18}H_{37}OH$, have also been studied, and their volumes are calculated by means of the expression—

$$\text{M. V. of } C_nH_{2n+1}OH = (6n+4)S = 6nS + 4S,$$

S having the same value as in the former series. Oxygen is thus found to have a volume equal to 2S in accordance with its valency-number.

These results were discussed in the light of the Barlow-Pope theory (*Trans.*, 1906, lxxxix., 1675).

232. "*The Action of Acid Chlorides on Thioureas.*" By Augustus Edward Dixon and John Hawthorne.

In former communications it has been shown that alkyl and aryl chlorocarbonates unite with thiourea, forming the hydrochlorides of basic derivatives, or pseudo-thioureas, $NH_2{\cdot}C(NH){\cdot}S{\cdot}CO_2{\cdot}R$; it is now established that Claus' compound of thiourea and acetyl chloride (*Ber.*, 1875, viii., 42) is similarly constituted.

Acetyl chloride unites spontaneously with monosubstituted aryl-thioureas, yielding compounds of the form $ArNH{\cdot}C(NH){\cdot}S{\cdot}COMe,HCl$; from these the corresponding picrates may be prepared. On withdrawing the combined hydrochloric acid by calcium carbonate or sodium ethoxide, the odour of thioacetic acid becomes perceptible; hence the base is probably liberated and then hydrolysed to a slight extent. Nevertheless, the product left on evaporation of the solution is not the free base, but an isomeride, the acetyl group having migrated from the sulphur to a nitrogen atom, so as to yield $AcArN{\cdot}CS{\cdot}NH_2$. The latter compound is known to change readily, by migration of its acyl group, into another isomeride, namely, the symmetrical $AcNH{\cdot}CS{\cdot}NHAr$; it appears, therefore, that by this series of transfers the acetyl group may be passed, in a given thiourea molecule, from point to point, until it has occupied, in succession, every position of attachment which a substituting group can assume. If the hydrogen chloride is eliminated by heat alone, the symmetrical or *ab*-thiocarbamide is produced; in like manner, Claus' compound yields acetylthiourea.

Benzoyl chloride behaves with thiourea and its aryl monosubstitution derivatives similarly to acetyl chloride; both chlorides unite with *ab*-aryl disubstituted thiocarbamides to form molecular additive products, the constitution of which has not yet been determined.

Disubstituted carbamic chlorides unite with thiourea, forming haloid salts; the corresponding nitrates and picrates are sparingly soluble in water.

Organic acid chlorides do not appear to combine with thioureas, which already contain an acidic group.

233. "*3-Hydroxyphthalic and 3-Methoxyphthalic Acids and their Derivatives.*" By William Henry Bentley, Rona Robinson, and Charles Weizmann.

An account was given of the preparation of 3-methoxyphthalic acid by the oxidation of 1 : 5-methoxynaphthol with alkaline permanganate, and of 3-hydroxyphthalic acid by fusion of 3-methoxyphthalic acid with caustic potash. A number of derivatives of each acid were described.

234. "*4-Hydroxyphthalic and 4-Methoxyphthalic Acids.*" By William Henry Bentley and Charles Weizmann.

The preparation of pure 4-hydroxyphthalic acid (m. p. 205°) from sulphophthalic acid by fusion with caustic potash was described, together with a number of derivatives of this acid.

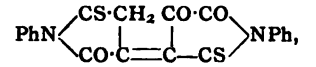
235. "*Derivatives of Naphthacenequinone.*" By William Henry Bentley, Arthur Friedl, Frederick Thomas, and Charles Weizmann.

This paper is a fifth contribution to the chemistry of naphthacenequinone (compare Diechler and Weizmann, Orchardson and Weizmann, *Ber.*, 1903, xxxvi., 547, 719, 2326; *Trans.*, 1906, lxxxix., 116), and contains a description of the preparation and properties of a large number of new hydroxy- and aminohydroxy-derivatives of this series.

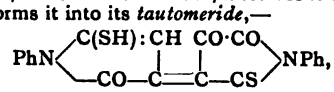
236. "*Dithioxanthoxalanil.*" (Preliminary Note). By Siegfried Ruhemann.

Thioacetanilide reacts with ethyl oxalate in the presence of sodium ethoxide to yield a compound similar to those which are formed from acetanilide and its homologues (Ruhemann, *Trans.*, 1906, lxxxix., 1236; *Proc.*, 1906, xxii., 284).

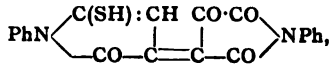
Dithioxanthoxalanil,—



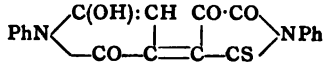
crystallises from glacial acetic acid in brown needles which decompose at about 235°. It differs from xanthoxalanil inasmuch as it is more stable towards caustic potash. The dilute alkali, or sodium carbonate, dissolves it on warming and transforms it into its *tautomeride*,—



which crystallises from alcohol in red needles decomposing at 195°, and is soluble in cold sodium carbonate. On boiling with caustic potash (10 to 15 per cent) one atom of sulphur is removed as hydrogen sulphide, and replaced by oxygen; the compound, *thioxanthoxalanil*, which is thus formed, crystallises from alcohol in shiny orange plates which decompose at 216—218°, and are soluble in sodium carbonate. The constitution of this substance is either—



or—



it is only decomposed by being heated with concentrated caustic potash (60 to 70 per cent), when oxalic acid and aniline are formed.

SOCIETY OF CHEMICAL INDUSTRY.
(London Section).

Ordinary Meeting, January 7th, 1907.

Mr. R. J. Friswell in the Chair.

"*The Sixth International Congress of Applied Chemistry at Rome.*" By W. F. Reid, F.I.C., F.C.S.

The author refers in the first instance to the great tendency of modern science towards specialisation, which is accompanied by so large a production of printed matter that personal intercourse between workers has become necessary to mutual agreement. The history of the International Congress of Applied Chemistry is briefly given from the first meeting in Belgium in 1894 down to that in Rome on April 25th of last year. Statistics of the expenditure and membership of the various Congresses are given, showing a very large increase in the last two Congresses. The organisation of such a Congress is described, and particulars of the opening of the Rome Congress by the King and Queen of Italy.

The procedure during the Session is explained, especially with regard to the language difficulty. Details are given of the amount of work done by each of the sixteen Sections and Sub-sections. The resolutions passed by the Congress in plenary sitting are given in detail, most of which refer to the international unification or standardisation of matters or methods connected with industrial chemistry. The invitation given by the British Joint Committee of Scientific Societies for the Congress to meet in London in 1909 is referred to, and the establishment of an Organising Committee here in furtherance of that object described. The entertainments and excursions given to members of the Congress were referred to and illustrated by lantern-slides, some of which were prepared from photographs sent by H.M. the King of Italy for the purpose.

"*The Determination of Higher Alcohols in Spirits.* Part I. *The 'Ester-iodine' Method.*" By G. H. Bedford, and R. L. Jenks (Central Excise Laboratory for India, Kasauli).

The authors point out the defects of the Allen-Marquardt process for the estimation of the higher alcohols in potable spirits. Dunstan and Dymond (*Pharm. Journ.*, xix., [3], 741) have shown how to determine organic nitrites by allowing them to act on an acid solution of potassium iodides in a flask void of oxygen, and then titrating the liberated iodine with thiosulphate. This serves as the basis of the authors' method. Details are given for the extraction and esterification of the total higher alcohols and the subsequent decomposition of the esters by iodine. Beckmann's method of esterification (one part of sodium nitrate and two parts of acid potassium sulphate powdered together) is employed. Results are given showing the accuracy of the method. An analysis can easily be carried out in a day.

"*The Determination of Indigotin in Commercial Indigo.*" By G. Bergtheil and R. V. Briggs.

The authors criticise Bloxam's method for the determination of indigotin (*Journ. Soc. Chem. Ind.*, 1906, xxv., 735), and point out that low results are obtained. The error is due to the factor on which the calculation is based, and the loss of indigotin which invariably occurs in salting out and filtering the sulphonic acid salt. A series of determinations were carried out by the authors' method (*Journ. Soc. Chem. Ind.*, 1906, xxv., 729), and by Bloxam's method (*loc. cit.*), and they are of opinion that the latter does not appear to be reliable either in application to pure indigotin or to commercial indigo. The method is cumbersome and inapplicable to work in the indigo districts of India, owing to the low temperature at which it is necessary to work, and the large amount of ice required for this purpose.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. clxiii., No. 17, December 31, 1906.

Butyric Lactone, and Disymmetric Bimethylated Succinic Glycol.—Louis Henry.—Except for the work by J. Houben entitled "The Reaction of the Organo-magnesium Compounds upon the Lactones" (*Berichte*, 1904), this reaction in connection with the group of internal ethers has not been investigated; M. Henry has therefore made it the subject of his experiments in the case of the simplest of the series, butyric lactone $CH_2—(CH_2)_2—CO$ (with O). This lactone is prepared by the dry distillation of the acid γ-chloro-butyric, $ClCH_2—(CH_3)_2—CO(OH)$. With the methyl-bromide or iodide of magnesium, ethyl acetate produces trimethyl-carbinol and ethyl alcohol:—

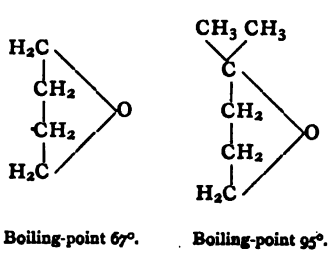
$$CH_3—CO \atop CH_3—CH_2 > O + 2CH_3.Mg.Br =$$

$$= \begin{matrix} CH_3 \\ CH_3 \end{matrix} > C—OH—CH_3 + CH_3—CH_2OH;$$

butyric lactone, which is this ether formed by the fusion into a unitary compound of the two CH_3 groups, changed to CH_2,—

$$\left[\begin{matrix} CH_3—CO \\ CH_3—CH_2 \end{matrix} > O \quad \begin{matrix} CH_2—CO \\ | \\ CH_2—CH_2 \end{matrix} > O \right],$$

ought to give the same products, but re-united into a single molecule, or rather into a unitary compound, *i.e.*, a primary and tertiary glycol, and, in the case of the methyl compounds, disymmetric, bimethylated succinic glycol, $\begin{matrix} H_3C \\ H_3C \end{matrix} > C(OH)—CH_2—CH_2—CH_2(OH)$. Experiment has fully confirmed these speculations. This glycol is a colourless liquid, thick and viscous, without smell, and with a bitter taste. Boiling-point 158° at 65° mm. Hg, 222° at 774 mm., easily soluble in water, soluble also in iether and acetone, and especially in chloroform; also in benzene slightly warmed; insoluble in petroleum. Submitted to the action of acetyl chloride, this glycol is converted into a chloro-acetine, with the formula $(H_3C)_2—CCl—CH_2—CH_2—CH_2—CH_2(C_2H_3O_2)$; this is a mobile colourless liquid, boiling at 132° at 70 mm., and at 190° at a pressure of 747 mm., whilst giving off hydrochloric acid. The glycol dissolves in fuming HCl, with transformation into its oxide. $(CH_3)_2.C—CH_2—CH_2—CH_2$ (with O). Again, heated with 15 per cent sulphuric acid, bimethylated succinic glycol is transformed into its anhydride, the oxide of bimethyltetramethylene, $\begin{matrix} CH_3 \\ CH_3 \end{matrix} > C—(CH_2)_2—CH_2$ (with O). Thus, under different conditions, the glycol is readily converted into this oxide, which is a colourless mobile liquid, lighter than water, in which it is insoluble. It boils at 95° under a pressure of 756 mm., and this assigns it a place between tetramethylene and the oxide of symmetric tetramethyl-tetramethylene:—



Boiling-point 67°. Boiling-point 95°. Boiling-point 117°.

A New Silicide of Manganese.—G. Gin.—This new silicide of manganese has been obtained by reduction of rhodomite in the electric furnace. The crystals, separated from the industrial product, gave the following analysis :—

	I.	II.
Manganese	68·64 per cent	69·26 per cent
Iron	4·40 „	3·18 „
Aluminium	0·74 „	0·60 „
Silicium	25·02 „	25·51 „
Carbon	0·16 „	0·18 „
Sulphur	0·01 „	—
Phosphorus	0·01 „	—
Losses (not weighed	1·02 „	1·27 „

Thus the silico-manganese investigated contained about 95 per cent of a crystallised silicide, to which the formula Si_2Mn_3 is given. This consists of beautiful prismatic crystals, very brittle, and fusible at 1250—1300°, attacked by chlorine at a red heat; pure oxygen does not act upon it at the ordinary temperature, but marks the surface towards 500°; gaseous hydracids attack it readily; sulphuric acid has no effect; nitric acid, aqua regia, and hydrochloric acids attack it in the warm, and hydrofluoric acid in the cold. Potassium, the alkaline carbonates, the mixtures of the fused nitrate and carbonate of potassium attack it energetically.

The Solubility of Carbon in the Protosulphide of Manganese.—M. Houdard.—The protosulphide of manganese is of remarkable stability, and, in the presence of carbon, there is no reduction of the sulphide, but simple solution in this compound to the state of graphite. The author has pursued the examination of this phenomenon and made two series of quantitative experiments. 1. A mixture of $MnSo_4$ (anhydrous) 100 grms., and C_4 (charcoal of burnt sugar) 31·78 grms., was heated in the electric furnace to produce the protosulphide. An excess of sugar-carbon corresponding to 10 per cent, *i.e.*, 11·11 grms., was added to the mixture. The only variable factor in this set of experiments was the duration of the operation. The following results were obtained :—

Time.	Percentage graphite dissolved.		Analysis of sulphide.	
Mins.	I.	II.	Mn, per cent.	S, per cent.
2 ..	0·0002	0·0007	63·22	36·77
3 ..	0·92	1·01	63·20	36·79
5 ..	1·39	1·40	63·19	35·98
8 ..	1·81	1·87	63·21	36·01
10 ..	2·22	2·24	63·21	36·35
15 ..	2·82	2·85	63·23	36·67
20 ..	3·01	3·21	63·18	36·71
25 ..	3·3c	3·25	63·29	36·70
Theoretical for MnS			63·218	36·782

The conclusions drawn from this table are that the sulphide is not reduced by carbon, and that the solubility of the latter is proportional to the time of heating, other things being constant. The limit of solubility was reached in the two last operations. 2. The bodies resulting from the shorter periods of heating, being full of bubbles (probably from formation of a certain quantity of Co), a second series of experiments was performed by calcination of the carbonate of manganese (perfectly dry) in a current of hydrogen sulphide. The analysis of the product thus obtained gave Mn 63·22 per cent and S 36·78 per cent, and this amorphous sulphide was heated in the furnace with sugar-charcoal in a charcoal boat. The results were as follows :—

Time.	Per cent graphite.		Analysis of sulphide.	
Mins.	I.	II.	Mn, per cent.	S, per cent.
3 ..	1·09	1·20	63·98	36·92
15 ..	2·79	2·80	63·11	36·87
20 ..	3·18	3·20	63·19	36·71
22 ..	3·11	3·12	63·20	35·97
25 ..	3·19	3·20	63·22	36·73

These figures are in accord with those of the first series, giving a maximum solubility of about 3·2 per cent.

Research on the Influence of Radicals on the Character of the Complementary Valencies of Oxygen.—M. Tchelinzef.—According to the researches of Blaise, the organo-magnesium compounds produced by the action of sulphuric ether upon organo-magnesium combinations of the type RMgI may be subdivided into two classes, the monoetherates, $RMgI.1(C_2H_5)_2O$, and the di-etherates, $RMgI.2(C_2H_5)_2O$, the formation of which may be attributed to the complementary atomicities possessed by the oxygen in ordinary ether. These complex bodies resemble, on the one hand, the bodies resulting from the action of the simple ethers upon the halogen acids, and, upon the other, the combinations of ether with magnesium iodide. For each of these classes of compounds are known the two series :—

$$HV.1(C_2H_5)_2O \text{ and } HV.2(C_2H_5)_2O;$$

$$Mg<^{I.1(C_2H_5)_2O}_{I.1(C_2H_5)_2O} \text{ and } Mg<^{I.2(C_2H_5)_2O}_{I.2(C_2H_5)_2O}.$$

These analogies favour the hypothesis according to which ether, in the organo-magnesium combinations, joins itself to the part of the molecule containing the haloid element. These considerations have led the author to attribute a similar constitution to the complex bodies formed by ether and the organo-magnesium radicles. The hypothesis of the existence of the complementary valencies of the oxygen may be equally extended to the di-etherates. The investigations pursued on these lines were based upon the thermal effect accompanying the reaction. The results obtained were as follows :—

Formula of ether.	$RMgI+R_2O$. q.	$RMgIR_2O+R_2O$. q'.	$Q=q+q'$.	Q found directly.
$C_2H_5.O.C_2H_5$..	6·63	6·16	12·79	12·60
$C_3H_7.O.C_2H_5$..	6·15	5·93	12·08	12·12
$iC_4H_9.O.C_2H_5$..	5·84	5·37	11·21	11·40
$iC_5H_{11}.O.C_2H_5$.	6·17	5·47	11·64	11·73
$iC_5H_{11}.O.C_5.H_{11}$	5·91	4·54	10·45	10·31
$C_6H_5.O.CH_3$ ..	—	—	—	—
$C_6H_5.O.C_2H_5$..	—	—	—	—

It follows from these figures that, judging by the thermal effect produced, the replacing of radicals by one another in the ethers of the fatty series modifies very slightly the character of the complementary valencies of the oxygen; but the introduction of the isoamyl group is followed by a still slighter evolution of heat. The nature of the reaction with the aromatic radicals is totally different, the thermic effect following the introduction of a phenyl radical being almost null. The complementary values of nitrogen are seen from the following data (from Thomson, Gauthier and Vignon) to present a similar phenomenon, with reference to the heat disengaged by the addition of certain acids to the tertiary amines :—

Formula of the tertiary amine.	HCl.	H_2SO_4.	$\frac{1}{2}H_2SO_4$.
$N(C_2H_5)_3$	9·5	—	—
$N(CH_3)_3$	8·3	21·8	10·3
$N(C_2H_5)(CH_3)_2$	6·8	15·2	7·6
$N(C_6H_5)_3$	0	0	0

Thus there is a similitude of properties between O and N, represented thus :—

$$R_2>O+<^{X}_{MgR} \quad \text{and} \quad \begin{matrix} R \\ R \\ R \end{matrix}>N+<^{X}_{H}.$$

Berichte der Deutschen Chemischen Gesellschaft.
Vol. xxxix., No. 15, 1906.

Benzoyl Nitrate, a New Nitrating Agent.—Francis Francis.—When silver nitrate acts on benzoyl chloride at a low temperature (about −15°) a yellow oil separates out. The equation is—

$$C_6H_5.CO.Cl+AgNO_3=C_6H_5.CO.O.NO_2+AgCl,$$

and the yield is almost quantitative. The oil is freed from silver salts by filtering through dry asbestos, care being taken to exclude all trace of moisture. If benzoyl nitrate is filtered through paper which has not previously

been dried an explosion occurs, the equation of the reaction being $C_6H_5.CO.O.NO_2 + H_2O = C_6H_5.COOH + HNO_3$. When it is cautiously heated to 100°, NO_2 and oxygen are evolved. The nitrate is characterised by the ease with which it exchanges its NO_3 group for hydrogen, and it is therefore applicable as a nitrating substance. It can be used either as such or in solution. It is best either to add a known volume of the nitrate to an excess of the substance to be nitrated, at the same time cooling, or to work with the latter diluted with carbon tetrachloride if the reaction proceeds too energetically. The benzoic acid formed during the reaction must be removed by a solution of caustic or carbonic alkali. The author has investigated many such nitration processes, and finds that the great advantage in using benzoyl nitrate is due to the fact that the operation can be performed in absence of water.

Velocity of the Addition of Bromine to Cinnamic Acid.—W. Herz and Bruno Mylius.—When bromine is added to a solution of cinnamic acid in chloroform the reaction which occurs is—

$$C_6H_5.CH:CH.COOH + Br_2 = C_6H_5.CHBr.CHBr.COOH.$$

In studying the velocity of this reaction the authors added titrated solutions of bromine in chloroform to cinnamic acid solutions of known strength contained in test-tubes. The test-tubes were then fused up, and the mixture kept at 25°. After definite periods the tubes were opened under potassium iodide solution, and the iodine corresponding to the unused bromine titrated with sodium thiosulphate solution and starch. They found that the equation of a bimolecular reaction, $\frac{1}{t(A-B)} \log \text{nat} \frac{B(A-x)}{A(B-x)} = \text{constant}$, holds good, A being the weight of cinnamic acid in 20 cc., B the weight of bromine in 20 cc., x the weight of substance used up, and t the time (in hours). Then other substances were added, *e.g.*, bromoform, iodine, &c. It was found that the former has no influence upon the velocity of the reaction, while the latter acts catalytically, the constant being ten times greater when iodine is added than when it is not. When carbon tetrachloride is used as solvent the constant is about three times as large as with chloroform, but the latter is much the more convenient in use.

Decomposition of Grape-sugar with Zinc Hydroxide-ammonia in presence of Acetaldehyde.—A. Windaus.—When acetaldehyde is added to a solution of grape-sugar in zinc hydroxide-ammonia, besides α-methyl-imidazol αμ-dimethyl-imidazol results. The constitution of this unknown imidazol was determined synthetically. It is formed from grape-sugar only on artificial addition of acetaldehyde, and if the latter is absent only monomethyl-imidazol results. Hence when grape-sugar is split up by hydroxyl ions in presence of ammonia, methyl glyoxal and formaldehyde are formed, but not acetaldehyde. The fact that grape-sugar can be split up by dilute alkalis under special conditions into acetaldehyde and formic acid is explained by supposing that when ammonia is present the intermediate substance (which yields acetaldehyde and formic acid) is caught by the ammonia, and converted into stable condensation products. The intermediate product is methyl glyoxal.

New Method of Nitrating.—Otto N. Witt and Alfred Utermann.—The general method of nitrating aromatic compounds is the addition of nitric acid together with some substance which will remove water, *e.g.*, sulphuric acid. The addition of this last often affects the position of the nitro group, and in cases where several isomers are simultaneously formed the relative quantities of the products are much altered. This is well shown in the case of aniline or acetanilide. The authors have studied the nitration of these substances, completely excluding all strong mineral acids, and using acetic anhydride to remove the water formed, and glacial acetic acid as solvent. To separate as accurately as possible the isomers contained in the raw product, distillation in a current of steam was employed. It was found that when aniline is nitrated by this method, to one part of the para compound not less than three parts of the ortho compound were formed.

Action of Hydrocyanic Acid upon Aldehyde Ammonia.—Giacomo Ciamician and P. Silber.—When dilute (3 per cent) hydrocyanic acid acts upon aldehyde ammonia slowly in the cold the results are very different from those obtained when concentrated solutions are used and heat is applied. The most important products are the two isomeric α-imidodipropionic acids; the A-α-acid melts at 255°, and the B-α-acid at 235°. The properties of the two acids are shown by the following table:—

Compounds.	A-α-Imidodipropionic acid.	B-α-Imidodipropionic acid.
Acid.	M.p. 254—255°.	M. p. 234—235°.
Acid barium salt.	Needles.	Gelatinous.
Neutral barium salt.	Sol. in cold water.	Insol. in cold water.
Silver compounds.	$C_6H_{10}O_4NAg + AgNO_3$.	$2C_6H_{10}O_4NAg + AgNO_3$.
Neutral silver salt.	Gelatinous ppt.	Powdery ppt.
Diethyl ester.	B. p. 123—124° at at 15 mm.	B. p. 121—122° at 15 mm. M. p. −5°.
Nitroso compound of diethyl ester.	B. p. 177° at 18 mm.	B. p. 163—164° at 17 mm.
Monamide.	$C_6H_{12}O_3N_2$. M. p. 232°.	$C_6H_{12}O_3N_2 + M.p. 210°. 1\frac{1}{4}H_2O$.
Imide.	—	M. p. 186°.
Nitrile.	M. p. 68°.	—

The isomerism of the two acids corresponds to that of the racemic and meso-tartaric acids; probably the A-acid is the racemic and the B-acid with the lower melting-point the inactive form.

MISCELLANEOUS.

Institute of Chemistry.—*Examinations in Chemical Technology.*—The next examinations in Chemical Technology will commence on Tuesday, April 23rd, 1907. The examinations will be open only to Fellows, and to those Associates who have been registered as such for at least one year, who produce evidence of practical technological training. Fellows and Associates who desire to present themselves are required to send in their applications and fees not later than Tuesday, February 26th, 1907. The Examination will be both written and oral, and will not extend over more than four days. The candidate is required to name some important industry, upon which his knowledge of the subjects of the Examination will be tested. The Examiners will take into account original work and special knowledge, but not so as to excuse the candidate from any part of the Examination.

NOTES AND QUERIES.

Beetroot Sugar.—A correspondent wishes to be told the best books on the beetroot sugar industry.

Fluor-spar.—Can anyone say what use is now being made of fluor-spar, for which there is said to be a great demand at the present time?

MEETINGS FOR THE WEEK.

TUESDAY, 22nd.—Royal Institution, 3. "The Sculpture of Aegina in Relation to Recent Discovery," by Prof. Percy Gardner, Litt.D., &c.

WEDNESDAY, 23rd.—Society of Arts, 8. "The Isthmus of Panama," by Philippe Bunau-Varilla.

THURSDAY, 24th.—Royal Institution, 3. "Recent Advances in the Exploration of the Atmosphere," by W. N. Shaw, M.A., &c.

—— Society of Arts, 4.30. (Indian Section)

FRIDAY, 25th.—Royal Institution, 9. "The Guildhall Library." by Charles Welch, F.S.A.

SATURDAY, 26th.—Royal Institution, 3. "Latest Phases of Music." (with Musical Illustrations), by Sir Alexander C. Mackenzie, Mus. Doc., &c.

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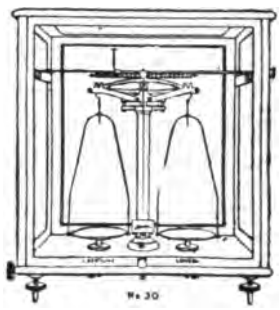

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NIOBIUM, TANTALUM, AND TITANIUM: OBSERVATIONS ON.

By W. B GILES, F.I.C.

(Continued from p. 3).

THE first object, that is to say, effecting the reduction of the acids as quickly as possible, is solved by replacing the rod, sheet, or granulated zinc by zinc-dust, or by the spongy zinc obtained by the electrolysis of zinc solutions. (In the same way spongy tin or copper may be employed). The saving of time that is effected in this manner is so remarkable that no one who has tried the two varieties of metals will ever revert to the use of the compact forms again. It is no exaggeration to say that by the use of the finely divided metals better results can be obtained in a few minutes than are possible in many hours when using the granulated form.

But this is not the only advantage; the finely divided metals react and enable reductions to be effected with many solutions (*e.g.*, those with organic acids) which have little or no action upon compact metals. The second object is to present the three acids to the reducing agents *in a soluble form*, and when these two conditions are combined it will be seen that one can easily detect a very small amount ol niobium mixed with either tantalic or titanic acid. The Schöene-Weller test for titanium (hydric peroxide), enables us to detect small amounts of this metal in presence of either of the others, and the only thing lacking is some process which will indicate tantalum with as much certainty when associated with the other two metals. It would appear, however, that up to the present time no direct test for tantalum is known by which it may be unmistakably identified when it is mixed with large quantities of the other acids. It is to be hoped that one may be discovered. In reference to this subject, the author has not been able to obtain good results by the process given by Dr. A. A. Noyes (CHEMICAL NEWS, vol. xciii., p. 180).

Trials have shown that freshly precipitated and undried tantalum hydroxide, whether alone or mixed with niobium or titanium, dissolves rather freely in a solution of hydrochloric or sulphuric acid, to which hydrogen peroxide has been added. Dr. Noyes's description of the process is:—"That tantalum hydroxide, whether present in small or large quantity, whether alone or with much titanium, remains in large part (about one-half) undissolved by this solvent." No explanation of this curious statement that "about one-half" of the tantalic acid declines to go into solution is given. Why should half the tantalic dissolve and the other half remain insoluble? One would almost infer that either the amount of peroxide of hydrogen or the hydrochloric or sulphuric acid used was insufficient. Direct trials with some of the mixed hydrated acids derived from columbite from Middleton, Connecticut, and also with those from Australian tantalite (sp. gr. 7·24) showed that they dissolve completely when diffused in dilute hydrochloric or sulphuric acid on addition of *sufficient* pure hydrogen peroxide (Merck's "perhydrol").

The solution is much assisted by *gentle* warming. It is possible that tantalic hydroxide is *more slowly* soluble than the corresponding niobic and titanic hydrates, but even if this is the case, the formation from the precipitate of insoluble oxyfluorides as a confirmatory test for the presence of tantalum cannot be regarded as decisive, for Krüss and Nilson (*Ber.*, 1881, p. 1676) showed that niobium potassium oxyfluoride gives a similar insoluble compound on boiling its solution, which they analysed and found it to be a potassium niobium dioxyfluoride; so that this test does not appear to afford a certain proof of the presence of tantalum. The most decided difference which the author has yet found in the behaviour of the three metals (apart from the double potassium fluorides) lies in *the remarkable insolubility of tantalum in potassium binoxalate in cold solutions*. If 1 grm. of pure ignited tantalic acid is fused with 2 grms. of pure potassium carbonate at a *high* temperature, it yields a perfectly clear fluid fusion; this dissolves in water to a perfectly clear solution. If to this is added 4 grms. of pure crystallised oxalic acid on making the liquid up to about 50·0 cc. and heating to boiling a perfectly clear solution is obtained, which is then made up to 100·0 cc. with hot water. On cooling and standing for twenty-four hours, the solution, when 100·0 cc., becomes quite thick and opaque, and deposits a large quantity of precipitate resembling ammonium magnesium phosphate. If the solution has only been made up to 50·0 cc. the solution becomes so solid on cooling (like blanc-mange) *that the flask may be inverted without spilling a drop*. If exactly the same weights of niobic and titanic are treated in the same manner, and made up to 100·0 cc., the solutions show nothing similar; they remain clear, at least for several days. When the thick tantalum solutions are heated they become perfectly clear again. This remarkable difference leads the author to hope that a further investigation of this matter (in which he is now engaged) may lead to some useful qualitative and possibly quantitative methods for the estimation and separation of tantalum.

In searching for soluble salts of the three metals, and such as are suitable for use with reducing agents, the number is seen to be but small. The fluorides are objectionable because they cannot be dealt with properly in glass vessels. Wollaston showed that the hydroxides of the metals were soluble in oxalic, citric, and tartaric acids, or in their acid salts, and since then racemic and lactic acids have been used as good solvents. Of these compounds only those with oxalic and citric acid have been tested, and of these two the oxalic compounds have been found, generally speaking, to be the most useful. These organic acids have one great drawback, and that is that they act as reducing agents themselves upon most oxidising bodies, and so they cannot find much application in quantitative work, but for qualitative purposes they are very useful.

After a great number of experiments the author could only find one suitable inorganic acid (excepting hydrofluoric) with which it is possible under some conditions to obtain fairly soluble salts. This was phosphoric acid, and it is somewhat remarkable that nearly all the acids yielding the most soluble salts of tantalum, niobium, and titanium are polybasic acids.

The hydroxides used in the following tests were obtained in a pure condition as follows:—The tantalic acid was made from twice re-crystallised tantalum-potassium fluoride, which was then precipitated with ammonia, the well washed precipitate re-dissolved in pure hydrofluoric acid; this solution precipitated again with ammonia barely to the neutral point, the precipitate thoroughly washed by decantation, dried, and ignited at a high temperature. It then only contained a very minute and just detectable amount of niobic acid, but appeared to be absolutely free from titanic acid, although the salt at the start contained a decided amount of the latter body. The niobic acid was prepared from well crystallised potassium fluoxyniobate; this also on starting was found to contain no inconsiderable amount of titanium. The salt was dissolved in water and well boiled, filtered from the insoluble matter, and then when cold the filtrate was precipitated with ammonia barely to the neutral point. The precipitate was thoroughly washed by decantation, and then re-dissolved in pure hydrofluoric acid; this solution was then diluted, and precipitated again with ammonia barely to the neutral point; the precipitate was then well washed by decantation, dried, and ignited at a high temperature.

Titanic acid was prepared from rutile by Wöhler's process; the titanic acid prepared from the well crystallised double fluoride by ammonia was snow-white; it was not dried but was preserved as a stiff paste.

In the following tables it is endeavoured to give as nearly as possible *the exact amount* of the strengths and quantities of the solutions and the reagents employed in order that the results may be repeated by any one who has an interest in the matter. Hence, such expressions as "a few drops," "enough," "an excess of," and the like are avoided.

Preparation of the Solutions.

Tantalum phosphate solution was made by taking 1 grm. pure ignited tantalic acid, fusing with 2 grms. of pure potassium carbonate at a very high heat till the fusion was clear, dissolving in water (the solution should be quite clear); to this adding 20·0 cc. of 1700 sp. gr. phosphoric acid, heating over a low flame till the mixture was much concentrated and appeared quite clear; when cold diluted with water up to 100·0 cc. This solution, at first perfectly clear, can be kept for a day or two, but gradually goes opalescent and turbid. The strong syrupy solution can be kept clear for a long time.

Tantalum oxalate solution is made exactly as above described, except that a solution of 4 grms. of pure oxalic acid is employed instead of phosphoric acid. The solution is made up to 100·0 *cc. when hot and clear;* it must be also *measured hot*, as it deposits greatly on cooling.

Niobium phosphate solutions are prepared precisely in the same way as the tantalum phosphate, only substituting 1 grm. of niobic anhydride for the tantalic anhydride; they do not keep long clear when diluted, but the concentrated syrupy solution will keep unaltered for a long time.

Niobium oxalate solution is made as the phosphate, from 1 grm. of ignited acid, 2 grms. of potassium carbonate fused together, and the clear solution heated with 4 grms. of pure oxalic acid. This solution keeps well, and if it deposits a trifle in cold weather it goes into solution again on warming.

Titanium Phosphate.—As titanium does not form soluble salts with the alkalis, and as the acid salts are difficultly soluble in phosphoric acid, this is made by dissolving titanic hydrate (which must not have been heated or dried) in the form of paste in *cold* strong phosphoric acid. The amount of titanic anhydride in the paste is ascertained by careful drying and ignition. Then an amount equal to 1·0 grm. of the anhydride is weighed out and dissolved in 20·0 cc. of 1700 sp. gr. phosphoric acid, and made up to 100·0 cc. This diluted solution does not remain clear for more than a few hours; it appears less stable than any of the other dilute phosphate solutions, but the strong solutions appear to remain unaltered for weeks.

Titanium oxalate solutions are made by dissolving titanic hydrate in hot potassium binoxalate and crystallising. The well defined crystals contain 22·5 to 23 per cent of titanic anhydride; the amount which is equivalent to 1 grm. of this is ascertained, and made up to 100·0 cc.; this solution keeps well, and only deposits slightly in cold weather.

Tests of the Niobium Oxalic Solutions.

1. Taken 10·0 cc. = 0·1 grm. Nb_2O_5. Added 1 grm. crystallised Ox, and boiled; then added 1 grm. zinc-dust. Result, *immediately*, a rich very strong brown colour almost *opaque* to transmitted light.

2. Taken 1·0 cc. = 0·01 grm. Nb_2O_5. Added 9·0 cc. water, 1 grm. crystallised Ox, and boiled; then added 1 grm. zinc-dust. Almost immediately a rich strong yellowish brown colour.

3. Taken 0·1 cc. = 0·001 grm. Nb_2O_5. Added 10·0 cc. water, 1 grm. crystallised Ox, and boiled; then added 1 grm. zinc-dust. Almost at once a very decided brown colour; this fades away quickly when the zinc-dust settles, but the colour can be restored by shaking up again; the solution should *not* be boiled after adding the zinc-dust. Evidently less than this amount could be detected.

4. Taken 10·0 cc. = 0·1 grm. Nb_2O_5. Added 1·0 cc. concentrated H_2SO_4; then zinc-dust. Solution becomes dark brown, then black, opaque to light.

5. Taken 1·0 cc. = 0·01 grm. Nb_2O_5. Added 9·0 cc. of water, and 1 cc. of H_2SO_4; added zinc-dust. Solution quickly becomes dark brown, then black; by transmitted light is seen to be of a brown-yellow hue.

6. Taken 0·1 cc. = 0·001 grm. Nb_2O_5. Added 10·0 cc. water and 1 cc. of H_2SO_4; added zinc-dust. This only gave a slight darkening on long contact. Not as delicate as No. 3.

7. Taken 10·0 cc. = 0·1 grm. Nb_2O_5. Added 1·0 cc. of 20 per cent pure hydrogen peroxide. Result, a faint straw-coloured solution equal to about one-fifth of a mgrm. of TiO_2.

Tests of the Niobium Phosphate Solutions.

8. Taken 10·0 cc. = 0·1 grm. Nb_2O_5. Heated to boiling, and added 1 grm. of zinc-dust. Result, *at once, an intensely black ink-like solution*, opaque to light.

9. Taken 1·0 cc. = 0·01 grm. Nb_2O_5. Added 2·0 cc. H_3PO_4 (sp. gr. 1500), and 7·0 cc. water, with 1 grm. zinc-dust. Almost immediately a black coloured solution; by transmitted light looks brown-red.

10. Taken 0·1 cc. = 0·001 grm. Nb_2O_5. Added 2·0 cc. H_3PO_4 (sp. gr. 1500), and 8·0 cc. water, boiled up, and then added zinc-dust, 1 grm. Distinct reaction, solution becomes dark and of a brownish colour. Takes about half-an-hour to develop.

11. Taken 10·0 cc. = 0·1 grm. of Nb_2O_5. Added 1·0 cc. of 20 per cent peroxide of hydrogen; slight but distinct pale yellow colour, equal to about one-third mgrm. TiO_2; more delicate than No. 7.

Tests of the Tantalum Solutions.

12. Taken 10·0 cc. tantalum phosphate, equal to 0·1 grm. Ta_2O_5. Boiled, added 1 grm. zinc-dust. No change.

13. Taken 10·0 cc. tantalum phosphate. Added 1 cc. of 20 per cent H_2O_2. No change; solution remains white.

14. Taken 10·0 cc. tantalum oxalate = 0·1 grm. Added 1·0 cc. of 20 per cent H_2O_2. No change; solution white.

15. Taken 10·0 cc. tantalum oxalate solution = 0·1 grm. Boiled, and added 1 grm. of zinc-dust. A very faint slight yellow shade, indicating a trace of niobium.

Tests of the Titanium Potassium Oxalate Solutions.

16. Taken 10·0 cc. = 0·1 grm. TiO_2 + 1 grm. crystallised Ox, boiled, then 1 grm. zinc-dust added; gave at once strong brown-yellow colour, not nearly as deep, however, in colour as the niobium (No. 1). When action is over solution looks like a saturated solution of $PtCl_4$.

17. Taken 1·0 cc. = 0·01 grm. TiO_2 + 1 grm. crystallised Ox + 9·0 cc. water, boiled, and then 1 grm. zinc-dust added and well shaken. Gave a strong yellow colour like saturated solution $K_2O.2CrO_3$.

18. Taken 0·1 cc. = 0·001 grm. of TiO_2 + 1 grm. crystallised Ox + 10·0 cc. of water, boiled, and then 1 grm. zinc-dust added, gave a light yellow solution, quite distinct.

19. Taken 10·0 cc. = 0·1 grm. of TiO_2 + 1·0 cc. of pure H_2SO_4. Added 1 grm. zinc-dust; *not* boiled; gave at once a *dark brown* colour. On standing some hours this changed to a purple or violet colour of much lighter hue.

20. Taken 1·0 cc. = 0·01 grm. of TiO_2 + 1·0 cc. of pure H_2SO_4 + 8 cc. of water + 1 grm. zinc-dust, *not* boiled; gave from the first a weak pale violet colour, at no stage brown. This solution, though ten times as strong as No. 18, is not as delicate.

21. Taken 10·0 cc. = 0·1 grm. TiO_2. Added 1·0 cc. 20 per cent H_2O_2. Deep orange colour at once like saturated $K_2O.2CrO_3$.

22. Taken 1·0 cc. = 0·01 grm. TiO_2. Added 1·0 cc. of 20 per cent H_2O_2. Bright yellow solution, like saturated potassium chromate.

23. Taken 0·1 cc. = 0·001 grm. TiO_2 + 1 cc. of 20 per cent H_2O_2. Bright yellow solution, evidently much less could be detected, but the colour in Nos. 21, 22, 23 is not so deep as in the phosphoric acid solutions of the same strength.

Tests of the Titanium Phosphoric Acid Solutions.

24. 10·0 cc. = 0·1 grm. TiO_2, gently heated, and then 1·0 grm. of zinc-dust added, gives a beautiful violet colour solution.

25. 1·0 cc. = 0·01 grm. TiO_2 + 9·0 cc. water heated to a boil, and then 1 grm. zinc-dust added, nearly all the TiO_2 precipitated apparently *as hydrate*; this was reduced on standing to a lilac coloured precipitate.

26. 1·0 cc. = 0·01 grm. TiO_2 + 2·0 cc. of 1500 sp. gr. H_3PO_4 + 7·0 cc. water, heated just to boil, and 1 grm. of zinc-dust added, gave a faint but still very distinctly coloured lilac solution. Weaker solutions were not tried, as this tint was so faint.

27. 10·0 cc. = 0·1 grm. TiO_2 + 1·0 cc. of 20 per cent H_2O_2. Immediate, deep orange colour.

28. 1·0 cc. = 0·01 grm. TiO_2 + 1·0 cc. of 20 per cent H_2O_2. Bright yellow colour, like saturated potassium chromate.

29. 0·1 cc. = 0·001 grm. TiO_2 + 1·0 cc. of 20 per cent H_2O_2. Light bright yellow solution, evidently much less could be detected. Note, Nos. 27, 28, 29 are considerably deeper in colour, and therefore more delicate than Nos. 21, 22, 23.

Summary of the Qualitative Tests.

Tantalum solutions, whether in oxalic or phosphoric acid, give no coloration when treated with zinc-dust as described.

Niobium solutions, both in oxalic or phosphoric acid, give deeply coloured solutions when treated with finely-divided zinc. These are *always either black, brown, or yellow*, according to the amount of dilution, but *never blue or violet*, providing a sufficient amount of free oxalic or phosphoric acid is present.

Titanium solutions *in oxalic acid* give reactions and colorations when reduced with zinc-dust much resembling those yielded by niobium, except that they are somewhat lighter in colour, but the solutions *in phosphoric acid always give violet or lilac coloured hues, and never black, brown, or yellow*, if sufficient free phosphoric acid is present.

In this way tests Nos. 1 and 8 will detect a very small amount of niobium mixed with tantalum, while Nos. 8 or 9 and 24 or 26 show a very marked difference between niobium and titanium. It has been noted that solutions of titanic acid in phosphoric acid are more sensitive when tested with hydrogen peroxide than the corresponding solutions in oxalic acid.

(To be continued).

THE EFFECT OF TEMPERATURE ON THE ACTIVITY OF RADIUM AND ITS TRANSFORMATION PRODUCTS.

By HOWARD L. BRONSON, Ph.D.

Introduction.

A LARGE number of investigators have attempted to alter the activity of various radio-active substances by subjecting them to very high and also to very low temperatures. Among all these attempts only two, as far as the writer is aware, have apparently given positive results.

Curie and Danne (*Comptes Rendus*, 1904, cxxxviii., 748) found that the rate of transformation of the active deposit from radium was apparently permanently increased, after it had been subjected to temperatures above 800° C. The writer repeated these experiments, and showed that this apparent increase was due to the volatilisation of radium B (*Am. Journ. Sci.*, July, 1905; *Phil. Mag.*, January, 1906). By having the active deposit sealed in a glass tube when heated, it was shown conclusively that the rate of transformation had not been permanently altered by temperature up to 1100° C. In both the above experiments the rate of transformation was determined in the cold after the active matter had been removed from the furnace, and no attempt was made to detect any change in the activity of the active deposit, while it was actually at a high temperature.

Results obtained by Makower.

Makower has more recently made some further investigations on the same subject (*Proc. Roy. Soc.*, March, 1906). He concludes:—"The results show clearly that the activity, as measured by the β and γ rays, can be changed by high temperatures, the observed effects being *consistent* with the explanation offered by Curie and Danne, that the rate of decay of radium C is increased by high temperatures." The method employed by Makower differed from that employed in the previous experiments, in that he subjected radium emanation (which was in a state of radio-active equilibrium) to the high temperature, instead of merely the active deposit. The emanation was sealed in a quartz tube, so that no volatile product could escape. This method had this advantage—that although the measurements were also taken when the tube was cold, yet it was possible to detect changes in the activity which had occurred during the time of heating. The activity of the quartz tube was always found to be diminished after it had been heated to 1000° C. or over. The amount of decrease varied from 3 to 15 per cent, depending on the temperature and length of time of heating. On account of the presence of the emanation, the activity recovered its normal value again after about one hour, apparently showing that, after heating, the rate of production of the active deposit was greater than the rate of decay. No light, however, was thrown on the question, investigated by Curie and Danne and the writer, as to whether the rate of decay of the active deposit had been *permanently* altered or not.

The arrangement of the apparatus employed by Makower is shown in Fig. 1. The ionisation in the testing vessel was produced by both β and γ rays, and it is easily seen that the distribution of the active deposit in the quartz tube might have considerable effect on the observed activity. It is also to be noticed that no change in the activity took place until a temperature of about 1000° C. was reached, which is about the temperature at which radium C begins to volatilise.

As all the results obtained by Makower can be satisfactorily explained on the assumption that radium C volatilised and deposited itself near the ends of the tube, it seemed desirable to further test the effect of high temperatures on the activity of radium and its transformation products under quite different experimental conditions.

Apparatus and Method.

The arrangement of the apparatus, as used in the following experiment, is shown in Fig. 2. A few tenths of a milligrm. of pure radium bromide was sealed in a quartz tube, under diminished pressure, and placed in a small electric furnace directly below the electroscope, as shown in the figure. In order to protect the electroscope from convection currents of air, it was entirely surrounded by another vessel and separated from the furnace by two layers of asbestos and one of lead, with air spaces between them. In addition to this, the air between the furnace and the electroscope was continuously removed by an electric fan, not shown in the figure. Even with these precautions the gold leaf did not move with perfect regularity, but the errors due to this fact were very small, as can be seen from the observations plotted in Fig. 3.

After several unsuccessful attempts, a satisfactory platinum resistance furnace was constructed, with which a temperature above 1600° C. was obtained. The construction of the furnace is shown in the figure. The inside cylinder was a platinum tube, which was surrounded by a layer of magnesium oxide in which the platinum wire was embedded. Surrounding the magnesium oxide was a porcelain tube, which in turn was covered with a thick layer of asbestos.

* Read before the Royal Society, November 15, 1906.

The temperature was measured by a platinum-rhodium thermo-couple and a potentiometer specially designed for such measurements by Professor H. M. Tory. The couple was calibrated up to 1100° by comparison with one of Dr. Barnes' platinum resistance thermometers, which had been carefully standardised. The calibration curve was extended beyond 1100° by means of an equation given by Le Chatelier. This equation is of the form $\log e = a \log t + b$,

The arrangement of the apparatus as described above furnishes certain favourable experimental conditions to which attention should be called. Errors due to change in the distribution of radium C were largely avoided by making the quartz tube short (about 4 cm.), in comparison with the diameter of the electroscope (about 12 cm.), and by measuring the activity entirely by the γ-rays. Any possible error introduced by the decay of the emanation

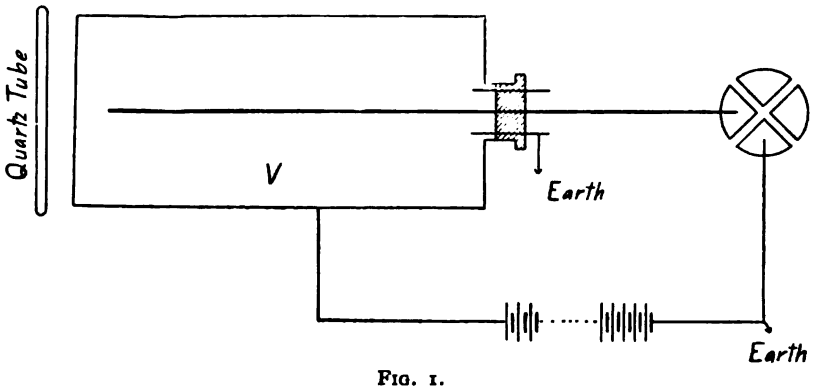

FIG. 1.

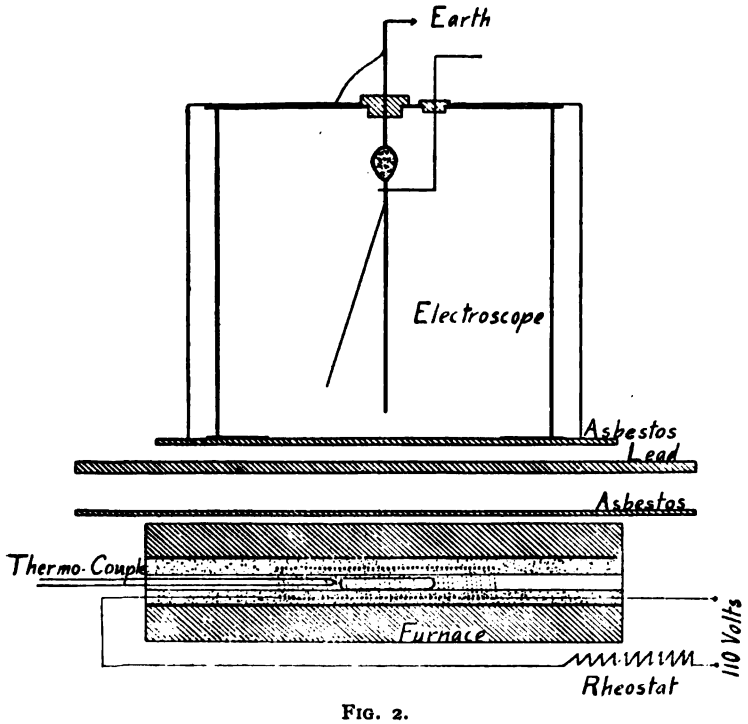

FIG. 2.

where e is expressed in micro-volts. This equation, with suitable constants, fitted the calibration curve almost perfectly below 1100°. In order to make certain that it held true for higher temperatures, the melting-point of platinum was directly determined, and was found to differ from the calculated value by less than 10°.

The relative position of the quartz tube and thermo-couple in the furnace is shown in the figure. It is easily seen that the temperature of the couple is certainly not higher than that of the quartz tube. It is therefore evident that the values given for the temperatures in this paper are certainly not too high.

was avoided by the use of radium itself as the active substance. The relative position of the quartz tube and the electroscope remained absolutely unchanged throughout the entire experiment. The *great* advantage, however, of the above arrangement lay in the fact that measurements of activity and temperature could be taken simultaneously. This made it possible instantly to detect any change in the activity of radium C., as its temperature was raised.

The importance of this point becomes evident, when we consider the complexity of the problem under investigation. This complexity arises from the fact that there were five radio-active substances in equilibrium, sealed together in

the quartz tube. Since the writer has shown that the rate of transformation of the active deposit is not permanently altered by subjecting it to temperatures up to 1100° C., the only explanation of the decrease of activity observed by Makower is that the equilibrium quantity of radium C at high temperatures is less than normal. A number of special cases will perhaps make this point more evident.

For simplicity we will assume that in any particular case only one of the active substances is affected by the temperature. For example, suppose that at a certain definite temperature the rate of transformation of radium C is suddenly increased, the electroscope will show a sudden increase in the activity. This increase in activity will not be permanent, but will gradually diminish and practically disappear after three hours. This follows from the fact that, when equilibrium is reached, the number of atoms of radium C, which break up per second, must be the same as the number supplied, and this number, according to our assumption, has not been changed. If now after equilibrium is reached at this temperature, the active matter is removed from the furnace and its activity measured again at ordinary temperature, it will be found to be less than normal, since the number of atoms of radium C present is less than the normal number. As a second example, suppose that the rate of transformation of radium B is suddenly increased. At once the activity of radium C begins to rise, reaches a maximum in about thirty-five minutes, and decays to its normal value again in about three hours. An increase in the rate of transformation of the emanation would produce similar results, except that it would take about three hours for the activity of radium C to reach a maximum, and as much as three or four weeks to decay to its normal value again. With radium A the case is quite different. Its rate of transformation is so rapid that it would regain its equilibrium value very quickly. Therefore, unless a very large change in its rate of transformation took place, the effect on the activity of radium C would be very small and difficult to detect. On the other hand, the rate of transformation of the emanation is so slow, that any change in the activity of radium would not appreciably affect the activity of radium C for several hours, and could not possibly be detected in the present experiment. The above discussion is all based on the assumption that the activity is being measured by the penetrating γ-rays, which come entirely from radium C.

It is thus clearly seen not only that it should be possible to determine the effect of high temperatures on the activity of the emanation and the active deposit, but that the particular substances affected ought also to be determined by the way in which the activity, as measured by the γ-rays, changes.

Observations.

When the apparatus was once arranged, as explained above, it was a very short simple operation to perform the experiment. Simultaneous observations of activity and temperature were taken at intervals of two or three minutes. The temperature of the furnace was raised gradually up to about 1300° C. It was allowed to remain between this temperature and 1350° for over an hour, and then gradually raised again to 1500°. After keeping it at about this temperature for nearly another hour, it was raised again to over 1600°. At about this temperature two difficulties were encountered, the insulation of the furnace failed, and the emanation began to escape from the quartz tube. The slightly increased activity shown by the last observation (Fig. 3) was due to this escape of the emanation and its presence around the electroscope. The furnace was then allowed to cool. Its activity measured several hours later was found to be less than half its original value. That this decrease in activity was actually due to the escape of the emanation was shown by the fact that the quartz tube regained about half its lost activity during the next four days.

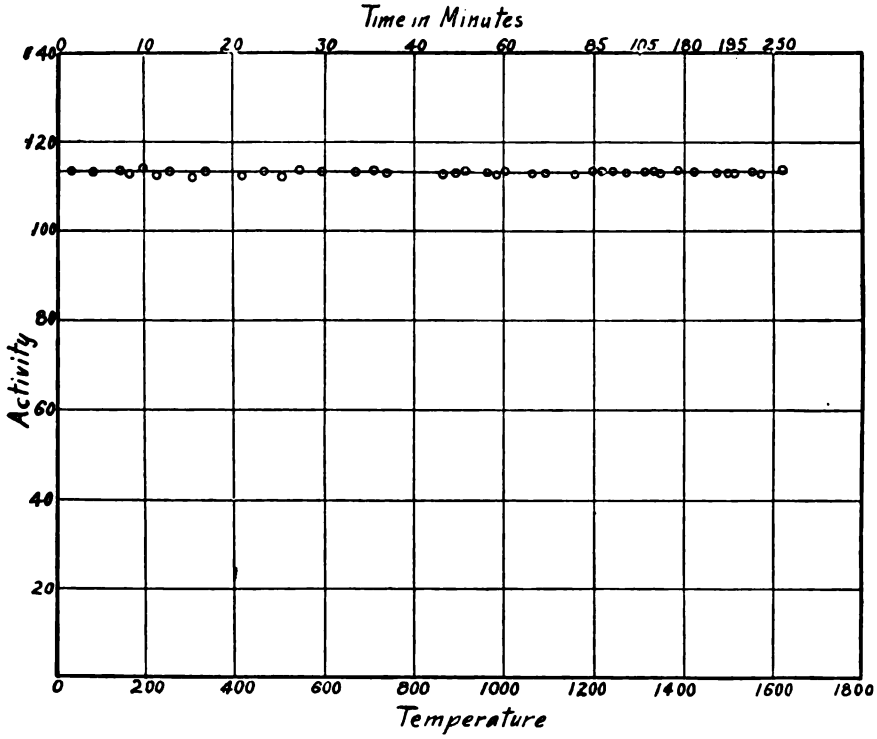

FIG. 3.

Fig. 3 shows the results of the series of observations above described. The approximate times at which the

measurements were taken are given at the top of the figure. Below 1200° each point in general represents a single observation, while above this temperature most of them represent a mean of several, which accounts for their greater regularity. There is no evidence of any change in the activity as measured by the penetrating γ-rays. If any change at all took place, it was certainly less than 1 per cent.

The length of time during which the temperature of the furnace was above 1500° was sufficient to have made it possible to detect a 1 per cent variation in the rate of transformation of either the emanation or radium B, but there was no evidence of any such change. A similar set of observations taken with decreasing temperatures also failed to reveal any change in the activity.

Effect of Low Temperature.

A number of investigators have tried the effect of subjecting radium to low temperatures, and have obtained negative results in every case. Nevertheless, it seemed worth while to supplement the above experiment by trying the effect of low temperature on the same radium that had been previously heated. Only one temperature was tried, namely, that of liquid air. The quartz tube was hung in a Dewar bulb beside the electroscope and its activity measured. The bulb was then filled with liquid air and measurements taken continuously for an hour, but there was no evidence of any change in the activity.

Conclusions.

The above experiments show no evidence whatever of any change in the activity of the transformation products of radium, when they are subjected to temperatures between −180° and 1600° C. If any change does take place, it is very small, and cannot be over 1 per cent in the case of radium C for temperatures between −180° and 1600°, nor more than 1 per cent in the case of the emanation or radium B for temperatures between −180° and 1500°.

There is thus removed the only known exception to the general rule, that the activity of radio-active substances is not affected by temperature.

In conclusion, I take pleasure in expressing my thanks to Professor Rutherford, who suggested the subject, and furnished all the necessary material for the investigation.

CALCIUM AS AN ABSORBENT OF GASES FOR THE PRODUCTION OF HIGH VACUA AND SPECTROSCOPIC RESEARCH.*

By FREDERICK SODDY, M.A., Lecturer in Physical Chemistry in the University of Glasgow.

(Continued from p. 28).

IX. *Quantity of Argon Detectable by the Spectroscope.*

If air is admitted to heated calcium the oxygen and nitrogen are absorbed almost instantly, and the argon and its companions in the atmosphere remain behind in a state of great purity and freedom from ordinary polyatomic gases. In the apparatus used an arrangement of two taps for admitting known small quantities of gas was joined to the apparatus for the absorption of gases by calcium. The space between the taps was 0·13 cc., and the total volume of the apparatus was 123 cc. The partial pressure of argon is 0·0094 of the atmospheric, or 7·1 mm. Each quantity or "dose" therefore of 0·13 cc. of air admitted to the apparatus corresponds to a pressure of argon of 0·0075 mm. of mercury. The vacuum-tube employed was an ordinary Plücker tube, with aluminium electrodes, of about 4·5 cc. capacity. It was found that no trace of the argon spectrum could be seen in the tube, and no discharge would pass through until three doses of air had been admitted and absorbed. At this stage the group of greens and the orange line in the spectrum were faintly visible. With four doses the red lines were visible momentarily as the nitrogen spectrum faded, and with five doses these became permanent. After ten doses (1·3 cc.) of air had been introduced the whole argon spectrum was brilliant; 4·5 cc. were so added in small quantities and then 3 cc. at once. In one minute the nitrogen spectrum began to clear, and 1·5 minutes the argon reds were visible. In two minutes nitrogen had disappeared, and in under three minutes only argon and hydrogen were visible. The hydrogen disappeared when the heat of the furnace was reduced, and the tube, giving a perfect argon spectrum, was sealed off as a memento of the experiment.

In another experiment the volume of the apparatus was 100 cc., and 12 cc. of air were admitted in one quantity after the calcium had been heated *in vacuo* to the absorbing temperature. This was absorbed without difficulty. The residual argon must have exerted about 1 mm. pressure. Yet the spectrum-tube showed brilliant green fluorescence. A tap was opened and the argon allowed to flow into a similar volume of 100 cc. which had previously been perfectly exhausted. The pressure was thus reduced to about 0·5 mm., and at this stage the spectrum-tube had a resistance equivalent to an alternative spark-gap of 5 mm.

It follows from these experiments that below a pressure of $\frac{1}{10}$ of a millimetre no discharge can be sent through a tube containing argon. At this pressure the greens and orange become faintly visible, and at $\frac{1}{15}$ of a millimetre the reds appear. At 0·5 mm. the resistance of the tube is still so high that the discharge prefers to jump an air gap 5 mm. long, while at a pressure of 1 mm. the tube is brightly fluorescent.

It was found that the substitution for the ordinary vacuum-tube of one of minimal volume with platinum electrodes did not much affect the pressure of gas at which the spectrum became visible. With a tube of 0·3 cc. volume, which is as small as it is convenient to employ, a quantity of argon, less than $\frac{1}{100}$ of a cubic millimetre, measured at normal temperature and pressure, could not be detected by the spectroscope. This applies to the pure gas in the absence of almost every trace of the relatively far more conducting polyatomic gases. As in the case of helium, to be considered, smaller quantities of argon could be detected in presence of hydrogen or other polyatomic gas.

X. *Misapprehensions Regarding High Vacua.*

The foregoing experiments with argon, and others of a similar character with other monatomic gases, serve to show that the characteristics of the electric discharge may prove a very faulty guide to the degree of a vacuum. The terms "X-ray vacuum," "fluorescent vacuum," &c., afford, apart from the knowledge of the character of the residual gas, no indication at all of the actual pressure. For if it happens that the residual gas is a pure monatomic gas, the fluorescent stage, and even the non-conducting stage, are reached at pressures within the range of the mercury barometer. These considerations serve to connect numerous isolated facts familiar to those who have worked with high vacua. Thus it is well known that to pump out a spectrum-tube with a mercury pump takes far less time if the gas pumped out is argon or helium than if air or hydrogen has been present.

[*Added*, Nov. 20.—It is also well known that in vacuum tubes filled with inert gases great heating of the electrodes occurs, even when these are made of aluminium, accompanied with the rapid disintegration of the electrode and the volatilisation of the aluminium (compare, for example, E. C. C. Baly, *Phil. Trans.*, 1903, A, vol. ccii., p. 183). At the same time a rapid exhaustion of the supply of gas apparently takes place, the vacuum appears to rise, the tube rapidly becomes fluorescent with use, and the resistance increases to the non-conducting point at which no discharge can be passed through the tube. In the past this has been attributed to the absorption of the gas by the

* Read before the Royal Society, November 15th, 1906

electrodes and the walls on which the volatilised aluminium is deposited. The advantages of aluminium over other metals, such as platinum, has been ascribed to a more rapid absorption in the case of the heavier metals (compare Travers, "Study of Gases," p. 299). Attempts to recover the gas supposed to be absorbed by heating the apparatus, solution of the metal electrodes, &c., have not been successful, as only a trace of the gas is recovered in this way.

The true explanation of the phenomenon is quite different, and follows simply from the experiments given in Section IX. for argon, and similar ones in Sections XI. and XII. for helium. The inert gases are not absorbed, but remain in undiminished quantity in the gaseous state in the tube, but the traces of ordinary chemically active gases always present initially or introduced from the electrodes during the discharge are absorbed, and the tube becomes in consequence non-conducting. The experiments of Skinner have an important bearing on this question, and in his most recent paper he summarises his conclusions (*Phil. Mag.*, November, 1906, p. 481). When a current is passed through a vacuum-tube, entirely independently of the nature or amount of gas filling the tube, hydrogen is evolved from the cathode and absorbed by the anode at a rate initially equal to that required by Faraday's law. Aluminium and magnesium cathodes give out hydrogen much more freely than the denser metals, but the rate of *evolution* from the cathode rapidly falls off as the supply of gas in the surface layers of the metal is exhausted. If the tube is allowed a rest the initial rate is recovered. When a continuous discharge is passed through any tube, therefore, the vacuum improves, for the rate of absorption by the anode gains on the rate of evolution from the cathode; and this should suffice to explain the well-known improvement with use in the vacuum of an X-ray tube. According to Skinner helium and argon are *not* absorbed by the electrodes, hence the rapid exhaustion or "running out" of the tube, and the advantages of the aluminium electrode are to be explained only in the manner indicated. It is intended to try, by passing a unidirectional current through a tube filled with inert gas, to what gas-pressure the non-conducting stage can be pushed. It is not a little remarkable, from the theoretical point of view, that helium, which conducts so much more readily than any other gas under usual conditions at high pressure, should exhibit the peculiar behaviour it does at low pressure in a state of purity.

Frequently in the work on the production of helium from radium, in conjunction with Sir William Ramsay, it was noticed when "running" a spectrum-tube to absorb nitrogen and reveal helium, if present, that, although a severe and prolonged running might be necessary to absorb the nitrogen, it always "ran out" first, and helium, however minute in quantity, showed itself, if present, as the nitrogen spectrum faded. When, however, the nitrogen spectrum had completely faded, which it did usually with great rapidity once it commenced to weaken visibly, the helium "ran out" almost instantly, if only in minute quantity, and the tube refused to conduct the discharge. This sharp preferential absorption, as it seemed, of the nitrogen first by the electrodes, so that even after a quarter of an hour's hard running the helium would survive, instantly to disappear as soon as the nitrogen faded, always seemed to me almost providential, until, recently, the true explanation became obvious.]

The explanation is also to hand why the presence of mercury vapour affects the action of the mercury pump so little. The vapour pressure of mercury at room temperature is between 1/500 and 1/1000 of a millimetre. In the case of hydrogen or carbon dioxide it is probable that this pressure would be sufficient to conduct the discharge and prevent the vacuum appearing very high to the electrical test. That "high vacua" can be obtained at all by the mercury pump is probably due to the fact that mercury vapour is monatomic.

Similar considerations apply to the vacua so readily and simply obtained by the use of charcoal cooled in liquid air, according to the method now largely used in scientific investigation and first employed by Sir James Dewar (*Proc. Roy. Soc.*, 1904, A, vol. lxxiv., pp. 122—131). It happens here also, as in the case of the calcium method, that the unabsorbed gases are monatomic. At liquid air temperature the helium and neon in the air remain very largely unabsorbed by charcoal. Sir W. Ramsay has determined in this way the proportion of these gases in the atmosphere, and found 17 parts per million of the two gases together (*Proc. Roy. Soc.*, 1905, A, vol. lxxvi., p. 111). An earlier determination made by Dewar, without the use of charcoal, was identical with this (*Proc. Roy. Inst.*, 1902, vol. xvii., pp. 223—230). The figures obtained by Ramsay, however, are for the total gases left uncondensed by charcoal at liquid air temperature, and have a direct bearing on the present question. Now as Lord Blythswood and Allen have shown (*Phil. Mag.*, October, 1905, p. 497), there is no difficulty in exhausting an X-ray bulb by the use of cooled charcoal from atmospheric pressure to the point at which it is difficult to force a discharge through the bulb. Yet the pressure of the helium and neon in the bulb must be 17 millionths of the initial pressure, or about $\frac{1}{7}$ of a millimetre. This result, although appearing strange by itself, is consistent with the experiment on the pressure of argon necessary to allow the discharge to pass. When any method of measuring the amount of gas remaining in the exhausted space, other than the electrical, is employed, the deficiencies of the non-conducting vacuum produced by cooled charcoal, when the vessel was originally filled with air at atmospheric pressure, become at once apparent. If, for example, the degree of vacuum obtained is measured by the rate of evaporation of liquid air in a Dewar flask, then the presence of these residual monatomic gases becomes all important. Experiments of a quantitative character on this subject are being made by Mr. Berry in this laboratory. (See addendum to this paper, *prox.*)

[*Added*, Nov. 20.—Lord Blythswood and H. S. Allen (*loc. cit.*), after showing, in the first part of their paper, that an X-ray bulb could be exhaused by cooled charcoal from atmospheric pressure in one hour to "a vacuum so good that the tube had to be heated in order to allow the discharge to pass through it," describe in the second part experiments in which the final pressures realised were measured by means of a McLeod gauge. When the apparatus was exhausted by a Fleuss pump initially to 40 mm., the final pressure attained was 0·0009 mm., whereas, starting from a pressure nearly atmospheric, the final pressure attained was ten times as great. They point out the importance of the preliminary exhaustion when an extremely high vacuum is required, owing to the presence of the less easily condensible gases, hydrogen, helium, and neon in the air, but do not refer to the apparent inconsistency between the results with the McLeod gauge and their earlier ones with the electric discharge test.

I was present at the meeting of the Philosophical Society of Glasgow (March 22, 1906), when Mr. Allen showed experimentally the exhaustion of an X-ray bulb from atmospheric pressure by cooled charcoal, and I was much impressed at the time with the apparent inconsistency between this result and the recent measurements of Sir W. Ramsay already cited.

The allusions in this section to the results of use of the charcoal method have reference solely to the phenomenon of the bad conducting quality of the residual inert gases that remain when air is absorbed from atmospheric pressure by use of charcoal or other methods. The question of the degree of vacuum produced under proper conditions for obtaining the best results is, of course, entirely different. Although the test of non-conductance, which has, so far, been relied upon implicitly for gauging the goodness of the vacuum, is useless, and may be actively misleading in the case of vacua obtained by the use of cooled charcoal without preliminary exhaustion by a pump (compare also G. Claude and Rene J. Levy, *Comptes Rendus*, 1906, vol. cxlii., p. 876), there is no doubt at all that, with suit-

able procedure, this method can give a very high degree of exhaustion. (*Cf.* the experiments described by Mr. Berry in the addendum to this paper).

XI. *Quantity of Pure Helium Detectable by the Spectroscope.*

Mixtures of known composition were made of helium and oxygen, and known quantities introduced into the calcium absorbing apparatus of known volume. The pressure of the residual helium could thus be calculated. In one case 0·13 cc. of helium was made up to 104 cc. with oxygen, so that the mixture contained $\frac{1}{8}$ per cent of helium. Successive quantities, each of 0·13 cc., were introduced into the apparatus, the volume of which was 89 cc., including an ordinary Plücker tube of volume 4·5 cc. The following observations are extracted from the note-book. The "quantities" referred to are each 0·13 cc. of the mixture, and the test of non-conductance was an alternative spark-gap of 2·5 cm. in air.

1st quantity.—Glimpse of D_3 for a fraction of a second as the oxygen spectrum suddenly cleared and tube became non-conducting.
2nd quantity.—D_3 clear while the tube conducted, which was but momentarily.
3rd quantity.—D_3 very pure and distinct, but tube became non-conducting.
5th quantity.—D_3 at first brighter than the mercury yellows.
6th quantity.—D_3 the brightest line at first except for the oxygen orange-red line.
7th quantity.—Just before the non-conducting point the general spectrum was plainly recognisable as helium.
8th quantity.—The brighter helium red (6677) visible.
9th quantity.—The two blues and violet seen.
10th quantity.—First glimpse of the peacock-green line (5016).
Tube took four minutes before it became non-conducting.
11th quantity.—Eight minutes before non-conductance.
13th quantity.—The helium spectrum was now quite good while it lasted, but the tube became non-conducting in three minutes.

The experiment was continued without much alteration up to the point at which thirty-five quantities had been added. The helium spectrum was plain, and indeed brilliant, so long as the tube conducted, but always a point was reached at which the discharge refused to pass. Diffusion was hastened by alternately heating and cooling the furnace. At the 35th quantity the tube conducted one way of the commutator and not the other, and this was taken as the limiting value. Later in the day and next morning the tube showed the same result. The discharge just passed, but the spectrum was feeble. The line D_3 was clear and the peacock-green exceedingly faint. These were the only helium lines visible.

The pressure of helium corresponding to each dose is 0·0014 mm., and to thirty-five doses 0·049 mm. It is thus clear that pure helium at a pressure of less than $\frac{1}{30}$ mm. is non-conducting to the discharge, while far less than this can be detected in presence of other gases. Like mercury vapour and krypton, a very small trace is visible in the spectrum of another gas. In the above experiments the D_3 line was visible plainly when only a single dose was added, so that to get the minimum quantity detectable a fresh series of experiments with more dilute mixtures was necessary.

XII. *Most Favourable Conditions for the Detection of Infinitesimal Quantities of Helium.*

Collie states that in presence of large quantities of mercury vapour the blue helium line, 4922, is the most delicate test for helium, and can easily be seen when none of the other helium lines are visible (*Proc. Roy. Soc.*, 1901, vol. xlxxxi., p. 25). It is likely, however, that the author mistook for helium a line in the spectrum of mercury which has the wave-length 4916·4 (Stark), and which is prominent in the mercury vapour-lamp spectrum. It is not often seen in the Plücker tube, except when the latter is warm and liquid mercury is present, so that the vapour pressure of the mercury is considerable. Collie has suggested for the calibration of spectroscopes a tube containing liquid mercury, helium, and hydrogen, as the spectrum consists of a large number of standard lines fairly equally distributed throughout the length of the spectrum. In such a tube I kept the blue line in question under close observation in a good spectroscope. With a feeble discharge, the tube cold and the mercury spectrum faint, this line was single and due to helium only. As the strength of the discharge was increased and the tube warmed, the mercury spectrum intensified, and a second line became visible on the more refrangible side of the helium line, and distant from it roughly about as far as D_3 is distant from D_2. On still further increasing the strength of discharge the helium line disappeared entirely, and the line was again single and due to mercury only. On diminishing the discharge and allowing the mercury vapour to re-condense, the less refrangible line reappeared and grew in strength as the other faded, and finally alone remained visible. Thus, it is clear that so far from enhancing the strength of the helium line, 4922, the presence of mercury serves to mask it completely even in presence of considerable quantities of helium. This line, 4916, is seen equally well in a tube containing mercury in which no helium has been introduced. Under no conditions tried has the line 4922 been seen when D_3 was invisible. The latter is by far the most delicate test for the presence of helium, and becomes visible with a quantity many times less than suffices to develop any other line in the spectrum.

Some experiments with various kinds and sizes of spectrum-tube, some with aluminium and others with platinum electrodes, showed that with minimal quantities of helium at similar *pressure* it is slightly easier to detect the D_3 line in the ordinary Plücker tube of volume 4·5 cc. than in a tube of minimum volume. But the difference is not great, and is mainly due to the sodium lines from the glass being more prominent in a tiny tube masking the D_3 line. Certainly, when the object is to detect the smallest possible *quantity* of helium, the tube should be of as small volume as possible. A series of experiments was tried in which the quantities of helium, far smaller than those necessary to allow the discharge to pass when in the pure state, were examined in presence of hydrogen and oxygen. A mixture containing 0·015 per cent of helium with oxygen was prepared by the principle of successive dilutions. Known quantities were introduced into the calcium absorption apparatus of known volume. After the oxygen had been completely absorbed, connection between the spectrum-tube and the absorption chamber was closed, and traces of oxygen and hydrogen introduced into the gas in the spectrum-tube. This was accomplished by heating a trace of solid potash, previously fused and freed from water, *in vacuo*, or by momentarily raising to redness a spiral of platinum wire by means of a current. It does not appear to make much difference which gas is added to conduct the discharge. After the first momentary heating platinum gives oxygen free from hydrogen. The potash gives hydrogen, doubtless as water vapour. The function of this gas is merely to cause the discharge to pass. Once established a large part, perhaps the larger part, of the current is carried by the helium, the spectrum of which, under these conditions, appears with extraordinarily minute quantities.

With an ordinary Plücker tube and an apparatus of volume 111 cc. after three doses, each of 0·13 cc. of the 0·015 per cent mixture, D_3 was but momentarily visible, and could not be again brought out by introducing oxygen or hydrogen. With four doses D_3 was faint but clear and permanent, and this may be taken as the extreme limit of visibility. The partial pressure, due to the helium at this stage, is only 1/100 of that necessary to conduct the discharge when pure, being 0·0005 mm. as compared with

0·05 mm. for the case of the pure gas discussed in the last section.

(The point was raised in the discussion of the paper, how far it had been actually proved that the inert gases were not absorbed, at least in part, by the walls and electrodes. The last experiment answers this question, for in a tube containing only one-hundredth of the quantity of helium necessary to conduct the discharge in the pure state, the helium spectrum may be brought out afresh by introducing a minute quantity of hydrogen or oxygen, which would not have been the case if the helium had been absorbed when the tube became non-conducting).

If a vacuum-tube of 0·3 cc. volume is used, it follows that a quantity of helium, 1/4000000 part of a cc., measured at normal temperature and pressure, would be within the range of detection by the spectroscope. For safety a margin of twice this quantity should be allowed, or 1/2000 of a cubic millimetre. This quantity weighs 10^{-10} grms., and contains about 2×10^{13} atoms. The delicacy of the test may be indicated by the following consideration:—It can be calculated on the assumption that the α-particle is an atom of helium, that a kilogrm. of uranium nitrate would generate 1 cc. of helium in a period of about 5000 years. The amount of helium produced in a single day should be within the range of spectroscopic detection. Researches on the production of helium from uranium and thorium have been in progress for some time, and it is hoped, now that the ground is cleared, that the matter would soon be put to a definite quantitative test.

In the above experiments the actual quantity of helium used was, of course, many times the amount finally examined in the spectrum tube. It is easy, however, to fill the absorption chamber after cooling completely with mercury, and to compress the gas into the spectrum tube. In this operation the minute quantity of hydrogen left unabsorbed by the calcium is, after the compression, just of the right amount to conduct the discharge and to reveal any trace of helium without any additional arrangement.

As an example of an actual experiment, one may be taken from the note-book from an examination of the gases present in native platinum. On the view that the scarcity of an element, after prolonged and extensive search for it, justifies the suspicion that it may be a member of a disintegration series, it was thought possible that evidence of such disintegration might appear in the presence of rare gases in platinum, as is the case with the radio-active minerals. Messrs. Johnson and Matthey very kindly lent me as much native platinum as required, and I desire to acknowledge my indebtedness to them for their kindness.

In one experiment a quantity of about 300 grms. was heated in a porcelain tube in an electric oven to 1200° C., and the gases passed into a calcium absorption chamber of the usual kind provided with a tiny spectrum tube at the upper end. A trace of carbon dioxide, from the walls probably, first came off. Then nitrogen appeared, and, as the temperature approached 800° C., carbon dioxide in quantity. On closing the connection with the platinum and absorbing the gas with calcium, the spectrum tube became quite non-conducting. These operations were repeated, the gas evolved being admitted and absorbed in stages. When the electric oven had reached a temperature of 1000° C. a momentary glimpse of the D_3 line was seen. At 1100° C. the peacock-green line was picked up, and the more prominent of the two reds seen extremely faintly. On forcing the discharge the argon greens could be faintly made out in a Ramsay pocket spectroscope. When the oven reached 1200° C., a large quantity of carbon dioxide had accumulated. This was admitted to the absorption chamber, and the connection sealed, and the heating of the platinum stopped. On cooling the calcium after absorbing the gases, the spectrum-tube was on the verge of non-conductance, but extremely faint helium could be detected. Mercury was admitted, and the contents compressed completely into the tiny spectrum tube. The helium spectrum was now reasonably bright, all the lines being visible, together with the hydrogen red and the mercury lines. With the pocket spectroscope argon could just be detected. It was estimated from the appearance of the discharge at various stages of the compression that about one-fifth of a cubic millimetre of helium was present, a quantity 400 times as much as could have been detected, yet only representing 1/15000000 per cent by weight of the platinum. The experiment lasted but two hours, and is given merely as an example of the ease with which an infinitesimal quantity of helium may be separated from large amounts of other gases by means of calcium, and its quantity estimated with fair probability. No weight is to be put on the result as indicating the origin of the helium. As a matter of fact, the native platinum was quite distinctly though feebly radio-active, 300 grms. of it in an electroscope producing an effect equivalent to 0·07 mgrm. of uranium oxide. Cleveite usually contains about 2 cc. of helium per grm., and is usually of about the same activity as uranium oxide. The platinum contained about 3,000,000 times less helium, and was about 4,000,000 times less radio-active than cleveite, so that there is no reason to go further to explain the source of the helium than to suppose that a trace of some radio-element is present in native platinum.

(To be continued).

NOTICES OF BOOKS.

Notes on Qualitative Analysis. By H. J. H. FENTON, Sc.D., &c. New Edition, Revised. Cambridge: The University Press. 1906.

WHEN this book was first published it was very well received, for it gave a complete course of qualitative analysis according to the usual schemes, while at the same time treating the subject far more fully than was then customary in an elementary book, and devoting more space to explanations and discussions of the various reactions. Although the time when practical chemistry from a school point of view meant nothing more than a course, generally imperfectly understood, of qualitative analysis, has now passed, let us hope for ever, the value of systematic analysis as a training is recognised on all sides, and teachers cannot do better than put this book into the hands of their pupils. The author in preparing the new edition has added many fresh methods and tests, and has increased the number of organic substances treated. A scheme is included for the identification of the common gases, and the classification of oxides is also briefly discussed. The theoretical explanations have been subjected to a careful revision, and the table of the examination of a substance for one acid radicle, which in the earlier editions required considerable amplification, has now been much enlarged and improved.

Producer Gas. By J. EMERSON DOWSON, M.Inst.C.E., M.Inst.M.E., and A. T. LARTER, B.Sc. (London), F.C.S. London, New York, and Bombay: Longmans, Green, and Co. 1906.

THE authors of this monograph write as enthusiastic believers in the great future which lies before producer gas, and as the book is practically the first of its scope it should be cordially welcomed by engineers, who will find it a valuable work in many respects. The subject is first treated from the theoretical point of view, and then the practical applications of the gas are classified and discussed, certain branches being treated comparatively fully; for instance, two chapters are devoted to the suction type of plant. The illustrations with which the book is provided are in most cases very diagrammatic, but they have the merit of being clear and easily understood. Interesting and lengthy accounts of the various tests which have been made with different types of plant are given, and the

chapter on the comparison of steam and gas power, in which the heat efficiency of a gas plant and gas-engine is considered and compared with that of a boiler and steam-engine of the same power, contains some striking figures and graphic representations.

The Scientists' Pocket-book and Diary. Manchester: James Woolley, Son, and Co., Ltd. 1907.

"The Scientists' Pocket-book and Diary" for 1907 contains a large amount of useful information, which has been judiciously selected. A particularly noticeable table is that which gives the properties and sources of the rare elements, and the most important physical constants of all the solid elements have also been tabulated. The little book is issued at a very modest price, and the statistics, as far as we have been able to test them, appear to be accurate.

Ice Formation. By Howard T. Barnes, M.A.Sc., D.Sc., F.R.S.C. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1906.

The practical importance of a thorough knowledge of ice phenomena to hydraulic engineers in Canada is immense, and the Associate Professor of Physics at the McGill University has rendered a public service to his countrymen in producing this admirable exposition of the subject. He bases his discussion of the formation of frazil and anchor ice, to which special reference is made, upon the study of the physical laws governing the transfer of heat, which he deals with in the first chapter, passing thence to the physical constants of ice and their determination. Recent work is carefully reviewed, and experimental details are fully described, while the later chapters on the formation and structure of ice are particularly interesting. Much of it, illustrated as it is by good photographs, will appeal to a wide public, and the extract from the Report of the Montreal Flood Commission gives the reader a very clear conception of the conditions which hold in the region of the St. Lawrence River. The description of the author's own experiments on the determination of the temperature of the waters of the river during the winter is preceded by a chapter on the measurement of temperature by refined methods, with special reference to the work of Prof. Callendar; the discussion of theories to account for the formation of anchor ice displays a somewhat marked partisan spirit, but also shows evidence of the author's originality and fertility of ideas. Although the book will naturally be more widely circulated in Canada than here, the author's extensive experimental work entitles him to the attention of scientific men of all nations, and his book gives a complete account of the phenomena of ice formation, collecting much scattered information and welding it into an interesting and valuable whole.

Outlines of Qualitative Chemical Analysis. By Frank Austin Gooch and Philip Embury Browning. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1906.

Although the authors of this book have some useful suggestions to make regarding the adoption of a few new tests and methods of separation, this fact hardly seems to warrant the production of a new book, in other respects very ordinary, on qualitative analysis, and there appears to be no real need to add to the number of books on routine work, which has been treated in many excellent and trustworthy text-books. However, this book has its good points. The introduction on procedure and principles is both interesting and clear, and is exactly what is wanted, being full enough and yet sufficiently condensed to give the lazy or hurried no pretext for skipping those theoretical considerations which are of the utmost importance and yet are frequently neglected. In minor details there is much to criticise unfavourably, and also a good deal to praise. To take the last first, the scheme of preliminary analysis is full and clear, and should give the student great assistance in the identification of unknown substances. The organic substances chosen for consideration are well selected, and the use of organic reagents in the separations (amyl alcohol, for example, to separate strontium and calcium) is sensible, and has many advantages. On the other hand, it ought to be recognised that some indications of the strengths of the reagents employed are essential to enable the student to work intelligently, and the scheme for acidic analysis is not as clear as it might be, while the value of the solubility table would be greatly increased if it gave the number of grammes dissolved per cubic centimetre in a saturated solution, instead of merely comparative information.

The Science Year-book, 1907. London: King, Sell, and Olding, Ltd.

Very few alterations have been made in the 1907 issue of this Year-book, which combines in one volume a diary, directory of scientific societies, and collection of biographical notices, besides containing many tables, astronomical, physical, and chemical. Special prominence is given to astronomical information, but practically all branches of science are represented, and the tables are very well arranged. The summaries of progress which were divided under different headings last year have now been condensed into one general article dealing shortly but adequately with the advancements and developments of the year 1906. For those who do not wish for the diary portion an abridged edition is issued; this contains all the matter of the Year-book without the Diary, and is naturally published at a lower price.

Post's Chemisch-Technische Analyse. ("Post's Technical Analytical Chemistry"). Edited by Dr. Bernhard Neumann. Third Edition. Braunschweig: Friedrich Vieweg und Sohn. 1906.

The new edition of this work contains much fresh matter relating to improved tests and processes, but the compiler's policy of rigorously excluding all unnecessary or out-of-date matter has enabled them to keep the book from becoming unwieldy, although it comprises a complete collection of the best methods of testing all technical products. The work is equally suitable for use in technical schools and colleges, and in works' laboratories, and every effort has been made to include only those processes which may be relied upon to give the most accurate results, and which are convenient in practice. It is issued in two volumes, each of which appears in four parts, dealing as far as possible with groups of allied industries, and the fact that each chapter has been written by a well-known specialist is a guarantee of trustworthiness. The book has been completely revised for the preparation of the third edition.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. clxiv., No. 1, January 7, 1907.

The Distillation of Alloys of Silver and Copper, of Silver and Tin, of Silver and Lead.—Henri Moissan and Tosio Watanabe.—By a series of distillation experiments, M. Moissan has already found the conditions of vaporisation of certain metals and their properties when condensed on a cold surface. The authors have attempted to verify these results by investigating the distillation in the electric furnace of a certain number of alloys. Volatile

metals were chosen for the purpose, the alloys containing one in common, viz., silver, so as to give comparable results. The time of heating was varied from one to fifteen minutes, the current being kept as constant as possible. 1. *Alloy of Silver and Copper.*—Results showed that the longer the distillation continued the richer the alloy became in copper, thus proving the boiling-point of copper to be higher than that of silver; the original alloy containing 49·55 per cent silver and 49·65 per cent copper, which after fifteen minutes' heating became 3·62 per cent silver and 95·22 per cent copper. 2. *Alloy of Silver and Tin.*—The original alloy contained 36·98 per cent silver and 64·04 per cent tin; after ten minutes' heating the composition changed to 2·93 per cent silver and 93·65 per cent tin, showing that the boiling-point of tin is higher than that of silver. 3. *Alloy of Silver and Lead.*—The alloy at the beginning contained 46·24 per cent silver and 52·95 per cent lead; after heating for two and a-half minutes, analysis showed the quantity of silver to be 93·81 per cent silver; hence lead distils more rapidly than silver. *Conclusions.*—These experiments, though performed in equal time intervals with all other conditions constant (ampèrage, voltage, diameter of electrodes, capacity of furnace), are not entirely comparable, because the amount of heat supplied by the arc in a cold apparatus or in an apparatus raised to 2000° is not the same for equal intervals of time. Hence, the results obtained are only approximate, but they serve to indicate that the four metals, according to their boiling-point, may be classed in the following order:—Lead, silver, copper, tin.

Alkaline Reduction of the Para- and Meta-Nitrobenzophenone.—P. Carré.—The author undertook the reduction of these two bodies by means of alcoholic soda and zinc, in order to ascertain the possibility of obtaining the corresponding azo-derivatives without alteration of the ketonic function. He, however, found this was not possible. Paranitrobenzophenone furnishes upon reduction a mixture of *p*-azo- and of *p*-azoxybenzophenone, and metanitrobenzophenone furnishes *m*-azoxybenzophenone with breaking down of the molecule in both cases.

Berichte der Deutschen Chemischen Gesellschaft.
Vol. xxxix., No. 16, 1906.

Compounds of Pentavalent Chromium.—R. F. Weinland and M. Fiederer.—The authors have found that chromium oxychloride can combine with the chlorides of the alkali metals, forming double salts which contain one molecule of chromium oxychloride to two of the alkali chloride, and no water of crystallisation. They are formed by dissolving chromic acid in water, adding hydrochloric acid cooled to −20°, and saturated with hydrochloric acid gas, and adding a strong solution of the alkali chloride to the oily chromium oxychloride which separates out, and leading in hydrochloric acid gas. The rubidium and cæsium salts form regular octahedra, and the potassium salt crystallises in the rhombic system. They behave very similarly to the corresponding pyridine and quinoline compounds. They are stable in dry air, but rapidly decompose in damp air. The aqueous solution gives with ammonia a precipitate of chromium hydroxide, and with lead acetate a precipitate of lead chromate. The pentavalency of chromium in the new double salts is proved by the fact that isomorphic mixtures of the cæsium salt with the analogous compound of niobium oxychloride can be prepared, and the niobium in the oxychloride is undoubtedly pentavalent.

Influence of the Chemical Constitution of Nitrogenous Food upon the Fermentive Power of Yeast.—Hans Pringsheim.—The author's experiments show that yeast grown in absence of sugar is capable of inducing fermentation if supplied with nitrogen in a suitable form. Thus after a growth of three months on a litre of malic or succinic acid with leucin as source of nitrogen the liquid is separated from the sediment of yeast, and sugar is added to the small amount of liquid remaining with the yeast; after twenty-four hours an appreciable development of gas occurs, and a loss of carbon dioxide is detected, amounting to 0·22 grm. with malic acid and 0·20 grm. with succinic acid. It has also been shown by the author that yeast can only cause the sugar given to it to ferment if the source of nitrogen contains the group .NH.CH.CO, while all other sources which do not possess this group cannot induce the formation of a fermentable plasma.

Determination of Halogens in Organic Compounds by means of Metallic Sodium and Ethyl Alcohol.—A. Stepanow.—The weighed substance, *e.g.*, monochlorbenzene, is put in an Erlenmeyer flask with 20 to 40 cc. of ethyl alcohol (98 per cent). The flask is connected with a long upright condenser, and put on a water-bath, and metallic sodium is then introduced through the condenser in large excess, the quantity being twenty times that required according to the equation—

$$R.Hlg + C_2H_5.OH + Na_2 = R.H + NaHlg + C_2H_5.ONa.$$

After the sodium has dissolved the contents of the flask are diluted with 20 to 40 cc. of water, and the alcohol is distilled off. Then dilute nitric acid is added to the cold liquid till its reaction is strongly acid, and the halogen is titrated by Volhard's method. This way of determining halogens is simple and quick, while the results obtained are very accurate.

Action of Phosphorus Pentabromide or Pentachloride on Phenol Alkyl Ethers.—W. Autenrieth and Paul Mühlinghaus.—When phosphorus pentachloride acts at a high temperature on alkyl ethers the following reaction occurs:—

$$CH_3.CH(OC_2H_5)_2 + PCl_5 = CH_3.CHCl.OC_2H_5 + POCl_3 + C_2H_5.Cl.$$

Hence it might be supposed that when phenol alkyl ethers were substituted the corresponding reaction, $Ph.O.R + PCl_5 = Ph.Cl + POCl_3 + RCl$, would occur. This, however, is not the case. When either PBr_5 or PCl_5 acts upon phenol alkyl ether, either in the cold or on gently warming, an energetic reaction occurs, and large volumes of hydrogen haloid are evolved, while phosphorus tribromide or trichloride and phenol ethers brominated or chlorinated in the benzene ring are formed. The reaction is represented by the equation—

$$C_6H_5.O.R + PBr_5 = C_6H_4Br.O.R + PBr_3 + HBr.$$

Naphthol ether reacts exceedingly easily, and all the reactions occur at temperatures considerably below the dissociation temperatures of phosphorus tribromide or trichloride. Substituted phenol ethers behave similarly, but in many cases it is necessary to heat for a long time on the water-bath. The general method adopted by the authors was as follows:—The phenol ether was placed in a dry flask with calcium chloride, and the thoroughly dried phosphorus pentabromide was added in small quantities, the whole being well shaken between each addition; then the mixture was heated for a short time (about ten to fifteen minutes) until the phosphorus haloid was dissolved, and the vigorous evolution of hydrogen haloid had nearly ceased. In most cases a reddish or brown coloured liquid was thus obtained. This was thoroughly shaken with large quantities of cold water when the brominated or chlorinated phenol alkyl ether separated, and could be shaken up with ether, and purified by fractional distillation or re-crystallisation. The yield amounted to 90 per cent or more of the theoretical yield.

Alteration in the Colours of Substances of Unalterable Constitution.—A. Hantzsch and W. H. Glover.—In the case of those coloured substances (mostly of the nature of salts) which are formed from colourless compounds by intramolecular transposition, and are either electrolytes or can yield electrolytes, by apparently simple substitutions, *e.g.*, of hydrogen by metals, the colour can be suddenly changed; it appears or disappears discontinuously, as in indicators. On the other hand, in the case of the coloured organic non-electrolytes, *e.g.*, azo bodies,

quinones, coloured diketones, &c., the colour can be continuously increased or diminished without intramolecular transpositions according to the nature of the groups combined with the chromophore molecules. These phenomena are well known, but have not been investigated quantitatively, partly because the accuracy of colorimetric experiments generally leaves much to be desired. The authors have examined the colour and colour intensity of various "indifferent" organic compounds with reference to their alteration by chemically indifferent substituents and by the influence of different solvents. They used König's spectral photometer, as modified by Martens and Grünbaum, and obtained concordant results with it. The substances investigated included bis-diphenylene ethylene, azobenzene and its derivatives, also quinones and quinone dioximes. As solvents absolute alcohol, ether, chloroform, benzene, ligroin, and hexane were used, as well as glacial acetic acid, acetone, and sometimes caustic soda. The results obtained may be collected as follows:—1. Beer's Law (that the colour intensity of a dissolved substance is directly proportional to its concentration) holds good for solutions of coloured non-electrolytes within all concentration limits (up to exceedingly great dilution). The deviations from the law observed in the case of electrolytes, and more especially coloured salts, are to be ascribed to chemical causes (hydrolysis, &c.). 2. The colour intensity of solutions of coloured non-electrolytes is dependent upon the nature of the solvent. Solvents containing oxygen, for example, water and alcohol, produce brighter colours than hycrocarbons, especially benzene. 3. The oxyazo-substances which produce salts (especially the quinone dioximes) give rise to intensely coloured alkali salts. The formation of salt must be accompanied by a chemical change, hence these substances are pseudo-acids. 4. By alkylating and acylating *p*-oxyazobenzene, and toluene azophenol, the colour is deepened, independently of the nature of the substituent, but almost proportionally to its molecular weight.

Triphenylmethyl and Trivalent Carbon.—Julius Schmidlin.—The magnesium compound of triphenylchlormethane occurs in two forms, one of which is decomposed by dilute hydrochloric acid giving triphenylmethane, while the other yields triphenylmethyl. When magnesium acts on triphenylchlormethane in ethereal solution, the magnesium compound of the triphenylmethyl type first results (the α-form). By heating this the stable β-form is obtained. The two substances are isomeric, and the formula of the β-substance is undoubtedly $(C_6H_5)_3C.MgCl$, and as triphenylmethyl can be obtained only from the α-form which does not contain the group $(C_6H_5)_3C$, triphenylmethyl itself cannot be $(C_6H_5)_3C$. The author has prepared the two magnesium compounds, and compared their properties, and has proved that there is no triphenylmethyl in the solution of the α-magnesium body, for, firstly, the peroxide formed by leading oxygen into the original solution of the magnesium compound arises, not from the previously formed triphenylmethyl, but directly from the magnesium compound, and, secondly, the triphenylmethyl resulting from the decomposition of the α-compound actually results at the moment of decomposition, and was not present in the solution previously.

MISCELLANEOUS.

Royal Institution.—On Tuesday next, January 29, at 3 o'clock, Professor A. C. Seward commences a course of two lectures at the Royal Iestitution on "Survivals from the Past in the Plant World"; on Thursday, January 31, at the same hour, Major P. A. MacMahon delivers the first of two lectures on "Standards of Weights and Measures"; and on Saturday, February 2, the Rev. W. Barry begins a course of two lectures on "Papal Deposing Power." The Friday Evening Discourse on February 1 will be delivered by Sir Almroth E. Wright on "The Methods of Combating the Bacteria of Disease in the Interior of the Organism," and on February 8 by Professor J. Gollancz on "Old English Poetry."

Appointment.—Professor G. P. Darnell Smith, B.Sc., F.I.C., F.C.S., has been appointed Assistant Director of Technical Education and Manual Training to the Board of Education, Auckland, New Zealand. Mr. Darnell Smith has been on the staff of the Merchant Venturers' Technical College, Bristol, since September, 1892; some time ago he was promoted to the post of Assistant Professor of Chemistry in the College.

MEETINGS FOR THE WEEK.

Monday, 28th.—Society of Arts, 8. (Cantor Lectures). "Gold Mining and Gold Production," by J. W. Gregory.

Tuesday, 29th.—Royal Institution, 3. "Survivals from the Past in the Plant World," by Prof. A. C. Seward, F.R.S.

—— Society of Arts, 8. "The Artistic Treatment of the Exterior of the Pianoforte," by Wm. Dale.

—— Faraday Society, 8. General Discussion on Osmotic Pressure. The Earl of Berkeley will exhibit and describe his Apparatus for the Direct Measurement of Osmotic Pressure. Mr. W. C. Dampier Whetham, F.R.S., will speak on "Indirect Methods of Measuring Osmotic Pressure." "Dr. T. M. Lowry will speak on "Osmotic Pressure from the Standpoint of the Kinetic Theory."

Wednesday, 30th.—Society of Arts, 8. "Apprenticeship," by James Parsons, M.A.

Thursday, 31st.—Royal Institution, 3. "Standards of Weights and Measures," by Major Percy A. Macmahon, F.R.S.

Friday, Feb. 1st.—Royal Institution, 9. "The Methods of Combating the Bacteria of Disease in the Interior of the Organism," by Sir Almroth E. Wright, F.R.S., &c.

Saturday, 2nd.—Royal Institution, 3. "Papal Deposing Power," by the Rev. William Barry, D.D.

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SCIENCE CLASSES, DAY & EVENING—

CHEMISTRY	ALEX. MCKENZIE, Ph.D., D.Sc., M.A.
PHYSICS	A. GRIFFITHS, D.Sc.
MATHEMATICS	E. H. SMART, M.A.
BOTANY	V. H. BLACKMAN, M.A.
ZOOLOGY	H. W. UNTHANK, B.A., B.Sc.
GEOLOGY & MINERALOGY	J. W. EVANS, D.Sc.
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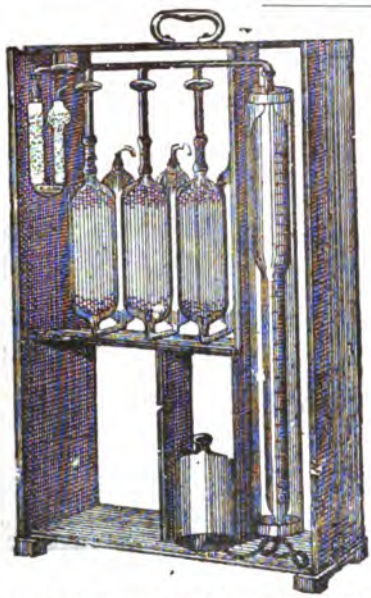

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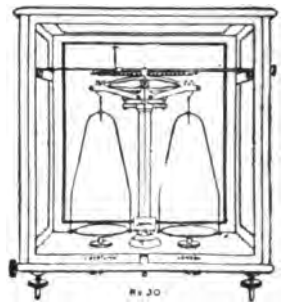

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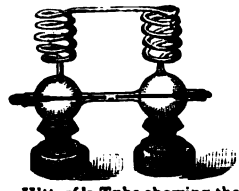

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THE CHEMICAL NEWS.

Vol. XCV., No. 2462.

VOLUMETRIC ESTIMATION OF ANTIMONY.

By J. B. DUNCAN. B.Sc.

About three years ago there appeared in the *Chemiker Zeitung* an article by Nissenson and Siedler on the volumetric estimation of antimony in hard lead by means of potassium bromate. The method was immediately tried by me in the laboratory of Messrs. Cookson and Co., Ltd., antimony smelters, where a number of accurate assays are required daily. It gave very good results. An attempt was then made to apply the method to ores and slags, and to diminish the time taken for an assay. After many trials the following modifications were found to give good results. They are rapid and equally applicable to alloys and ores, and have been in constant use ever since.

A solution of potassium bromate is prepared by dissolving 2·7852 grms. in a litre of water and standardised by the following process:—Weigh out 0·3 grm. of pure finely divided antimony metal. Place in a 16 oz. beaker, cover, and add 20 cc. of strong hydrochloric acid and a few drops of bromine. Keep warm, with occasional shaking, until the metal is dissolved. Boil off the excess of bromine, cool a little, and then add about 0·75 grm. of sodium sulphite, and boil the mixture down to about half its volume to drive off sulphur dioxide. (In the case of alloys this latter operation will also remove any arsenic present). Rinse the cover and sides of beaker with hot water, and add a little hydrochloric acid. The liquid is then heated to boiling, and the bromate added from a burette until nearly all the antimony has been oxidised. Three drops of methyl-orange solution are now added, and the bromate run in until the colour of the methyl-orange is destroyed. The number of cc. of bromate used is equivalent to 0·3 grm. of antimony. A duplicate assay is made. The amount of bromate required in each case should be the same, and will approximately be 50 cc. Thus, 1 cc. of the bromate is equivalent to about 0·006 grm. antimony. The standardisation of the bromate may also be made on antimony oxide, or an alloy of antimony and lead of known antimony content. Such a solution, kept in a blue stoppered bottle, was re-standardised at the end of a month, and found to be practically unaltered. The following results show the effect of various impurities upon the accuracy of the method, the assay in each case being made in a similar manner:—

Antimony. Grm.	Added impurity. Per cent.	Bromate required. Cc.	Antimony, theoretical. Per cent.	Antimony, estimated. Per cent.
0·2	Nil	32·75	100·00	100·00
0·2	25 Fe	32·75	80·00	80·00
0·2	50 Fe	33·70	66·66	68·60
0·2	10 As	32·80	90·91	91·09
0·2	10 Sn	32·75	90·91	90·91
0·2	10 (As, Fe, Sn)	32·80	76·92	77·08
0·2	2·5 Cu	32·75	97·56	97·56
0·2	5·0 Cu	32·75	95·23	95·23
0·2	25 Cu	33·75	80·00	82·48

It is not common to have 10 per cent of any of the above impurities in a sample of hard lead. Small quantities do not affect the result to any appreciable extent. With 25 per cent of iron present it is difficult to tell the end reaction.

Hard Lead.—The sample, cast into a small ingot, is sawn obliquely through the middle with a fine saw, and the sawings sifted through a 30-mesh sieve. Weigh out 0·3 grm. of the sifted portion, place in a 16 oz. beaker, cover, and add 20 cc. strong hydrochloric acid, and boil gently for a few minutes; then while hot add a few cc. of a saturated solution of bromine in hydrochloric acid, and shake occasionally until the alloy is dissolved. The method is now exactly the same as that described in the standardisation of the bromate solution. Should a little chloride of lead crystallise out during the titration the result is not affected, but the liquid should not be allowed to cool too much. If the sample is boiled with hydrochloric acid alone, before adding the bromine, a saving of time is effected, and the results obtained are the same. The time taken for the assay is twenty-five minutes.

Sulphide ores, in which the antimony is completely soluble in hydrochloric acid and bromine, are treated as follows:—

Direct Method.—A small portion of the sample is crushed to pass completely through a 60-mesh sieve, and afterwards thoroughly mixed. 0·3 grm. is weighed into a 16 oz. beaker, and treated as described for alloys.

Oxide and Sulphide Ores, Soluble or Insoluble in Acids (Fusion Method).—0·3 grm. of the finely divided sample, intimately mixed with three or four times its weight of a mixture of equal parts of sodium carbonate and sulphur, is heated in a porcelain crucible, with lid, at a gentle heat for about fifteen minutes. The crucible and contents are allowed to cool, and the fused product is extracted with boiling water, and the solution filtered at the pump. The filter-paper, which contains the insoluble sulphides of copper, iron, &c., and possibly a little antimony, is transferred to a small beaker, and treated with a little hot hydrochloric acid. Now add caustic soda until nearly neutral, then sodium sulphide in excess, boil, and filter. The small quantity of antimony is now in solution and is added to the main bulk. (In the case of ores containing little impurities other than silica, the antimony is rendered completely soluble by the first fusion, and the above operation is unnecessary).

The antimony is precipitated as sulphide by the addition of hydrochloric acid, and the liquid warmed until the antimony sulphide settles. It is then filtered through a Gooch crucible, the bottom of which is covered with a layer of asbestos fibre. The sulphide is quickly filtered off, washed, and is then, together with the asbestos, transferred to a 16 oz. beaker, with the aid of a glass rod and a fine jet of strong hydrochloric acid. The volume of acid is made up to 25 cc., and boiled until the sulphuretted hydrogen is driven off. It is now cooled a little, a few drops of liquid bromine added, and boiled gently until the sulphur liquefies. Rinse the sides and cover of the beaker with a little cold water, filter through a small filter-paper, wash with a little hydrochloric acid, and, finally, with hot water. The filtrate is then boiled to remove excess of bromine, cooled, sodium sulphite added, and the antimony estimated as above. (Time taken for assay is one and a-half hours). The following examples show some results obtained:—

		Antimony. Per cent.
A. Sample of antimony oxide ..	Direct ..	82·34
	Fusion ..	82·24
B. Mixture of oxide and sulphide	Direct ..	55·73 (*a*)
	Fusion ..	56·73
	Gravimetric	56·80
C. Mixture of oxide and sulphide	Direct ..	60·89
	Fusion ..	60·83
	Gravimetric	60·92
D. Mixture of oxide and sulphide	Direct ..	61·53
	Fusion ..	61·58

(*a*) 1·0 per cent insoluble in acid.

Small quantities of antimony in slags, &c., can be estimated by first separating the antimony as sulphide, and treating as described above.

THE THERMO-CHEMISTRY OF NITROGEN.

By J. C. THOMLINSON, B.Sc. (A.Sc., Durham Coll. of Science).

From the large mass of thermo-chemical data available we have already shown conclusive reasoning for the existence of thermo-chemical equivalents for certain of the elements.

We are now considering nitrogen as regards its thermal relations in the compounds in which it occurs, but, in the first place, recur to the compounds hydrogen peroxide, H_2O_2, and ozone, O_3, which have the heats of formation given below:—

$$H_2 + O_2 = H_2O_2 + 45{\cdot}300 \text{ cals.} \quad . \; . \; . \quad \text{I.}$$
$$3O_2 = 2O_3 - 68{\cdot}000 \text{ cals.} \quad . \; . \; . \quad \text{II.}$$

The value H = 7·470 cals. for the heat of combination of hydrogen has already been found in a large number of cases to give, in the compounds in which it occurs, calculated heats of formation for these compounds agreeing with those found experimentally, and applying this value to Equation I., we obtain for oxygen in hydrogen peroxide a heat of combination O = 15·180 cals., the value already found for divalent oxygen being 52·545 cals.

In the three best known oxides of nitrogen, which we here represent with their heats of formation,—

N_2O .. .. = − 17·470 cals.
NO .. .. = − 21·575 „
NO_2 .. .. = − 2·005 „

it is evident since these all have a negative value that oxygen has probably in these compounds a very different thermal value from that found for divalent oxygen, and we are led by analogy to suppose that oxygen is other than divalent in hydrogen peroxide and ozone. Suppose, for example, that oxygen is quadrivalent in hydrogen peroxide, we should represent it structurally—

$$H_2 + O_2 = \begin{matrix} H-O \\ \| \\ H-O \end{matrix} + 45{\cdot}300 \text{ cals.}$$

from which it follows that quadrivalent oxygen has the value $O\equiv = 15{\cdot}180$ cals. already found, the difference between di- and quadrivalent oxygen amounting to 52·545 − 15·180 = 37·365. Hence, the addition of another bond to quadrivalent oxygen might be supposed to cause a further reduction of half this difference, or 18·683 cals., and pentavalent oxygen if such existed would have a value $O\overline{\equiv}$ = 15·180 − 18·683 cals. = − 3·503 cals.

In the molecule of oxygen, O_2, there is little reason for choosing between a di- or pentavalent character from a purely chemical point of view, and we might represent it O=O or $O\equiv O$, whence, reasoning from the latter of these formulæ, the thermal behaviour of ozone in changing to oxygen at once becomes clear. For if we represent oxygen as quadrivalent in ozone and pentavalent in the oxygen molecule, this reaction would be represented—

$$2O\begin{matrix} \diagup O \\ \| \\ \diagdown O \end{matrix} = 3O\overline{\equiv}O + 68{\cdot}000 \text{ cals.}$$

in which six quadrivalent oxygen atoms become pentavalent, changing from a thermal value + 15·180 cals. to − 3·503 cals.; that is to say, by calculation a heat evolution equal to 11·677 × 6 = 70·062 cals. should take place, that found by experiment being 68·000 cals., the two figures showing a close agreement.

The application of this preliminary consideration of the thermal value and valency of oxygen will become clear when we deal with the oxides of nitrogen, but in this connection we will first take up the case of the cyanogen compounds and ammonia.

Hydrocyanic acid is formed with an absorption of heat, H + C + N = − 27·480 cals., whilst for hydrogen and carbon we have already found thermo-chemical equivalents, H = 7·470 cals. and $C\overline{\equiv}$ = − 8·130 cals., from which it follows that in this compound the atom of nitrogen represents in the thermal equation a heat absorption, $N\overline{\equiv}$ = − 26·820 cals., which value applied to the compound cyanogen, C_2N_2, gives a calculated heat of formation, − 16·260 cals. − 53·640 cals. = − 69·900 cals.; that found by experiment being − 65·700 cals.

Here, again, we have an agreement between theory and experiment, and will now turn to ammonia, NH_3, which is formed with an evolution of heat, $N + H_3 = NH_3 + 11{\cdot}890$ cals., from which the thermal value of the nitrogen atom is found to be $-(3 \times 7{\cdot}470 - 11{\cdot}890) = -10{\cdot}520$ cals.

These values for nitrogen in hydrocyanic acid and ammonia, together with the knowledge that cyanogen forms well characterised normal and iso-compounds, in the latter of which it must be regarded as pentavalent, would justify us in believing nitrogen to be pentavalent in the comparatively unstable compounds hydrocyanic acid and cyanogen, and trivalent in ammonja.

Thus, $N\overline{\equiv}$ = − 26·820 cals. and $N\equiv$ = − 10·520 cals., and we will find that these values are fully borne out when applied to the oxides of nitrogen, the formulæ of which have already been given.

If in nitrous oxide, N_2O, oxygen be represented as pentavalent, but with the difference that in the structural formula shown below, in which nitrogen is trivalent, there is one oxygen bond of valency which forms a central union in the molecule, without affecting the trivalency of nitrogen, and which bond is equivalent to a heat evolution, + 3·503 cals., instead of the absorption, − 3·503 cals., for pentavalent oxygen referred to as possible when considering ozone, then such a bond would account for the comparative stability of nitrous oxide, and the heat of formation of this compound would be 2 × − 10·520 + 3·503 = − 17·537 cals., the experimental value for the heat of formation of nitrous oxide being = − 17·470 cals.

$$\begin{matrix} N\overline{\equiv} \\ \| \\ N\equiv \end{matrix} O = -17{\cdot}470 \text{ cals.}$$

This assumption of a central bond of union is not only justified by the stability of nitrous oxide, but the positive value given to it would merely represent the amount of heat given out by a pentavalent atom in a molecule of oxygen if the thermal relations supposed above in connection with ozone were correct on the rupture of this molecule.

Similarly, in nitric oxide in which we regard nitrogen and oxygen as pentavalent with the formula $N\overline{\equiv}O$, and where, again, we represent a similar central bond of union by a thickened line in the formula, we should expect a heat of formation, − 26·820 + 3·503 = − 23·317 cals., the value found by experiment being − 21·575 cals.

Nitrogen dioxide may be represented by the structural formula—

$$N\begin{matrix} \diagup O \\ \| \\ \diagdown O \end{matrix} = -2{\cdot}005 \text{ cals.};$$

in which nitrogen is trivalent, and oxygen pentavalent, the two atoms of oxygen in this case contributing to form the central bond of union, and hence giving a heat of formation of this compound, − 10·520 + 2 × 3·503 cals. = − 3·514 cals., the experimental value being − 2·005 cals.

In viewing these three oxides of nitrogen we feel justified from the agreement of theory and experiment in giving them the structural formulæ here represented, especially when we consider the order of their stability, nitrous oxide being most stable, nitric oxide least so, and nitrogen dioxide intermediate between the two, and also the fact that nitrogen dioxide is formed by the mere contact of nitric oxide with atmospheric oxygen, the formation of the dioxide taking place under just such conditions as here represented.

Further, in giving a numerical value to the part played by oxygen in forming a central bond in these compounds we do not pretend to anything more than approximation.

We conclude by giving a comparative statement of the results obtained by theory as shown against those actually found experimentally.

	Experimental value.	Theoretical value.
$2O_3 = 3O_2$ ..	+68·000 cals.	70·062 cals.
$C_2 + N_2 = C_2N_2$ ..	−65·700 „	−69·900 „
$N_2 + O = N_2O$ ..	−17·470 „	−17·537 „
$N + O = NO$ ..	−21·575 „	−23·317 „
$N + O_2 = NO_2$ ..	−2·005 „	−3·514 „

CALCIUM AS AN ABSORBENT OF GASES FOR THE PRODUCTION OF HIGH VACUA AND SPECTROSCOPIC RESEARCH.*

By FREDERICK SODDY, M.A., Lecturer in Physical Chemistry in the University of Glasgow.

(Concluded from p. 45).

APPENDIX.—*Results of Gauging High Vacua by the Evaporation Test.*

By ARTHUR JOHN BERRY.

IN this note the results of some experiments, on the rate of evaporation of liquid air contained in a Dewar vessel exhausted in different ways, are described with the view to showing that this test may be used as a means of gauging the degree of vacuum produced by different processes. Owing to various causes the research has not been carried as far as it was intended, but one set of measurements, complete in themselves, have been obtained which bear out in a clear manner one of the points discussed by Mr. Soddy in the paper preceding. Starting with a vessel filled with air at atmospheric pressure, there is no difficulty, by using the method of Sir James Dewar to produce a vacuum therein, in obtaining a vacuum apparently perfect, so far as the electric discharge test can indicate, provided that a sufficiency of charcoal is employed. It was of interest to compare the rate of evaporation of liquid air in a Dewar vessel exhausted in this manner, with the rate in the same vessel exhausted also by Dewar's method, but in which the air had been first removed by an auxiliary pump. Although the electrical test reveals no difference in the degree of vacuum obtained in the two methods, it is to be expected that the thermal test will show a far higher vacuum by the second method than by the first, owing to the residuum of non-conducting inert gases left by the first method (compare Lord Blythswood and H. S. Allen, *Phil. Mag.*, October, 1905, p. 497). This expectation has been fully borne out by the experiments.

The vessel employed was of about 1 litre capacity, globular in form, and silvered on the two inner walls. During the exhaustions it was placed in an inverted position in an air oven, and the temperature maintained at 350° C. A vacuum-tube served to indicate the progress of the exhaustion. At the completion of each exhaustion it was filled with liquid air, and kept in an ice chest to keep the external temperature constant. The vessel was weighed at regular intervals to determine the rate of evaporation of the air. Three different methods of exhaustion, designated throughout I., II., III., were employed.

I. In the first the exhaustion was performed by the mercury pump. A Töpler pump of ordinary pattern, worked by hand, was used, and pumping was continued from four to five hours while the vessel was heated in the air oven. The pump had a capacity of about 350 cc., and was provided with a phosphorus pentoxide tube and tap. The results of two similar experiments agreed well among themselves, and in the table the second of the two, which was slightly the better, is alone included.

II. In the second method the apparatus was exhausted from atmospheric pressure by cooled charcoal. As in the experiments of Lord Blythswood and Mr. H. S. Allen (*loc. cit.*) two separate charcoal bulbs were employed, the one with 97 grms. and the other with 70 grms. of charcoal freshly prepared from cocoanut shells. The first bulb alone reduced the pressure from atmospheric to the fluorescent stage in thirty minutes, and was then cut out and the second bulb brought into action. The absorption was continued one and a half hours further, and the vessel sealed off. No discharge could be sent through the vacuum-tube at this stage.

III. The same vessel was exhausted by a duplex Fleuss pump of large size, mechanically driven, and during the action of the pump the charcoal was well heated. In this way carbon dioxide is expelled from the charcoal, and the last traces of air are swept out. It was found in a separate experiment that little or no difference was produced in the result by the displacement of the last of the air by oxygen during pumping. In this method only one charcoal bulb was used, which was connected direct by a glass tube without taps to the vessel being exhausted. The connection with the pump was sealed after the removal of the air was judged complete, and the absorption by charcoal continued for two and a half hours.

The following table shows the results of the three methods. Weighings were taken at intervals of either six or twelve hours. The first column shows the time in hours from the first weighing, and the total weight of liquid air initially present in the three experiments is indicated in the first line. The succeeding lines indicate the amount that has evaporated in the six or twelve-hour interval from the previous weighing:—

Hours.	I. (*a*)	II.	III.
0	972 grms.	954 grms.	979 grms.
12	2×54·5	2×63	2×40·5
18	54	62	40
24	54	60	39
36	2×54·5	2×60	2×39
42	54	59	39
48	55	58	37
60	2×56	2×57·5	2×37
66	56	57	37
72	57	56	37
84	2×58·5	2×56	2×37
90	58	55	38
96	59	56	36
	(78 remaining)	(18 remaining)	
108	—	—	2×37
114	—	—	38
120	—	—	36
132	—	—	2×36
138	—	—	36
144	—	—	37
			(78 remaining)

(*a*) The slight increase in the rate of evaporation during this experiment is due to a shortage in the supply of ice in the ice-chest. In the other two experiments the chest was kept well filled.

It will be seen at a glance that whereas the vacuum resulting in the second method, by cooled charcoal, but starting from atmospheric pressure, is inferior to that produced by a simple mercury pump, that obtained in the third method, by charcoal after removal of the air, is by far the best of the three. After six days 78 grms. of liquid air out of the original kilogramme remain in the vessel.

In conclusion, I desire to take this opportunity of expressing my indebtedness to Mr. Soddy, at whose suggestion the research was undertaken, for placing the apparatus required at my disposal and for many valuable suggestions.

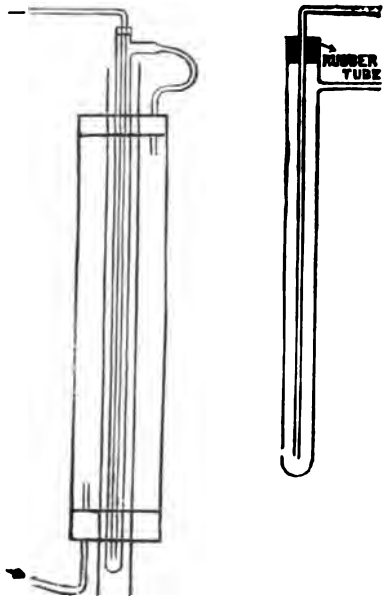
* Read before the Royal Society, November 15th, 1906

IMPROVED LIEBIG'S CONDENSER.

By HENRY R. ELLIS, B.Sc., F.C.S.

THE following is a description of a very simple device for improving the efficiency of a Liebig's condenser when used as a reflux with volatile liquids:—

By inserting in the middle tube of the condenser a tube, as shown in the figure, and passing the water from the



outer tube of the condenser through this, the cooling surface is much increased.

BORIC ACID: ITS DETECTION AND DETERMINATION IN LARGE OR SMALL AMOUNTS.*

By WILSON H. LOW.

MANY good articles have been published on the detection and determination of boric acid, but they are rather fragmentary in character, and while helping in one direction, have left much to be desired in another. Most processes are tedious of execution, and do not give evidence that all the boric acid will be obtained.

I have discovered two points in regard to the detection and determination of boric acid which I believe are new.

One of these is that in the qualitative test it is not necessary to dry the turmeric paper at the temperature of the water-bath, but that the test carried on at the ordinary temperature in the air or vacuum desiccator, or even at 40° to 50° in a desiccator, is exceedingly delicate, and allows the detection of boric acid in the presence of large amounts of other salts, and in the presence of such interfering agents as nitrates and phosphates, when it would be entirely overlooked by the ordinary methods.

I do not know the limit of the qualitative test, but such small quantities of boric acid as 0·000001 grm. in 1 cc. or 0·0000001 grm. in 0·10 cc. are easily recognised, and these same quantities would undoubtedly be recognised by the evaporation of larger quantities of the solvent.

The other point applies to the quantitative determination. It is very difficult to distil off all the boric acid from an aqueous solution, by passing the vapour of methyl alcohol through it. As long as any quantity of water remains it will retain boric acid, but it has been found that, by adding some substance to unite with the water, it is possible to distil off the total boric acid easily and with no tedious evaporation to dryness, with the attendant bumping and danger of breakage. Such a substance is the dry, granulated, chemically pure calcium chloride.

The methods described below have been in use about three years, and a great many experiments have been made to test the various points brought out. Further experiments will bring out other points of value, but the methods are in good shape, and if followed as directed, will give the desired result. The methods will first be given as they are expected to be carried out, and further on will be given the experiments, or some of them, on which the processes stand. The action of indicators in the presence of boric acid and in the presence of methyl alcohol will also be given.

Wherever methyl alcohol is mentioned, the laboratory refined Columbian or Colonial spirits of commerce is meant. In the refined state, as it is purchased, it contains boric acid, and this has to be removed, and the alcohol tested to make sure it is entirely free from it.

Qualitative Test.

The test is given as applied to meat products, but obviously it may be applied to anything where the boric acid can be obtained in a soluble form. Ten grms. of the hashed meat are placed in a metal dish (the cover of a three-pound lard pail is as good as anything, if well cleaned), and moistened with 5 cc. of a N/2 solution of sodium carbonate or its equivalent. Place on the steam-bath or in an oven till about dry. Drying may be done nicely on a small electric stove. Ignite the dry mass, over a burner that heats the whole bottom of the dish evenly. Do not use a high heat. Thoroughly carbonise the ash, but do not bother to burn off much of it. Burning off is dangerous, as boron compounds may be volatilised when ignited in the presence of carbon. Direct experiments have shown this. The carbonised ash is placed in a mortar (a glass mortar is best), and ground up somewhat, and then about 10 cc. of water containing 1 cc. of strong hydrochloric acid added, and triturated with it. Filter off through a small filter (a small Witt's plate is best, as it retains very little liquid) into a flat platinum or glass dish. A Petri dish 7—10 cm. in diameter is good.

About 1 cc. or less of the solution is taken and placed in a watch-glass, and evaporated on the steam-bath with a piece of turmeric paper. If boric acid is present in the food product as a preservative, and there are no interfering agents, such as nitre, present, then a test for boric acid will be obtained here. This does not mean that if a test is obtained here the food product necessarily contained boric acid added for preserving purposes, but merely that the test is delicate enough to detect any possible amount of boric acid that would be added intentionally. The main lot of solution is placed in a shallow dish with a piece of turmeric paper, and then placed in a desiccator till *perfectly* dry. A vacuum drying oven is best, as the drying is rapid. I use a vacuum drying oven, and can control the heat, using generally 40° to 50°, and about 700 mm. vacuum. The smallest traces of boric acid will show up in this test. It is more delicate, if anything, if the drying is done in an ordinary desiccator, but the time of drying is very long. Tests that fail utterly on the steam-bath will show up strongly under these conditions. Nothing which I have tried, such as nitre, salt, sulphates, or even phosphoric acid, has interfered with the test. Nitre will destroy the test carried on on the steam-bath, and many other salts will seriously interfere. Make sure the turmeric paper is perfectly dry, for incrusting salts often give the appearance of dryness while the underlying paper is still moist. Food products should not be con-

* From the *Journal of the American Chemical Society*, xxviii., No. 7.

demned because a strong test is obtained by operating in this manner. Added boric acid is easily detected by moistening the turmeric paper with the solution and drying on the steam-bath. If nitre is present, it can be gotten rid of (for the steam-bath test) by igniting with sufficient organic matter, or, better, by distilling off the boric acid with methyl alcohol, and testing the distillate. In testing qualitatively, the best result seems to be given with a solution containing at least one-tenth its volume of free strong hydrochloric acid, if the test is made on the steam-bath. For the test at ordinary temperature or at 40° to 50°, a slight excess of acid is all that is needed, though greater excess does no harm. For the delicate test I should advise against the use of the trade mark glasses, as they are borosilicates, and I have some indications that they will give up boric acid.

In the following tests the final volume before evaporation was 2 cc. unless otherwise stated. The turmeric paper was about 50×9 mm., and the ordinary paper supplied by chemical dealers. A steam-bath was used with the first twenty tests.

The last test repeated on the steam-bath will bleach the paper owing to the formation of chlorine compounds.

Many other tests have been tried, and nothing found to interfere with the test made by drying in the vacuum desiccator or oven.

There appears to be no loss of boric acid in concentrating a large volume of solution in the vacuum, and the test is just as strong as where only 1 cc. is used. 0·00001 grm. of boric acid is equivalent to 0·0001 per cent when 10 grms. of material are operated on, and this qusntity is infinitesimal for a preservative. As far as that is concerned, the simplest kind of a test, carried out in the roughest manner, is amply delicate to detect any boric acid added for preserving purposes. The exception to be noted is where there is a nitrate present.

Quantitative Test.

Reagents.—Methyl alcohol free from boric acid; methyl-orange indicator; *p*-nitrophenol indicator; phenolphthalein indicator; hydrochloric acid free from boric acid; calcium chloride, granulated, chemically pure; standard solution of sodium hydroxide, as free as possible free from carbonate; standard solution of sulphuric acid, as free as possible from carbonate; whether these solutions are normal or of other strength depends on what quantity of boric acid is being dealt with. Both normal and tenth-normal are useful.

Standard Solutions.—The standard solutions of acid and alkali are made up in the Laboratory of the Cudahy Packing Company from distilled water which has been distilled from a block-tin (solid) still and condenser, and subsequently boiled hard for about twenty minutes in another block-tin vessel furnished with a connection to a large soda-lime column. After boiling, the vessel is furnished with a tin condensing pipe inside to cool the water rapidly. All air entering the vessel has to come through the soda-lime column, and the water keeps free from carbonic acid. While 100 cc. of the ordinary distilled water will take about 15 drops of N/10 sodium hydroxide solution to give a *permanent* coloration with phenolphthalein, the boiled water allows the permanent coloration to show up strongly with one drop, and this is almost sufficient for a litre of the boiled water. Incidentally, I will remark that sodium thiosulphate solutions made up with this water will keep their correct strength almost indefinitely, and deposit no sulphur.

Preparation of the Methyl Alcohol.—"Columbian" or "Colonial Spirits" are introduced into a still of some kind, and made *strongly* alkaline with some very concentrated caustic soda or potash. If a glass vessel is used, it must be furnished with a capillary boiling tube, and the size of this tube adapted to the size of the flask, &c. (see Heyward Scudder, *Journ. Am. Chem. Soc.*, xxv., 163).

Test.	Final volume of solution. Cc.	Boric acid present. Grms.	Excess of strong HCl. Drops.	Other things present.	Indications.
1.	2·00	0·0000000	2	Nothing	None
2.	2·00	0·0000010	2	Nothing	Merest trace
3.	2·00	0·0000100	2	Nothing	Strong test
4.	2·00	0·0000050	2	Nothing	Strong test
5.	2·00	0·000025	2	Nothing	Slight test
6.	2·00	None added	2	1 cc. N/1 NaOH	None
7.	2·00	0·0000025	2	1 cc. N/1 NaOH	None
8.	2·00	0·0000050	4	1 cc. N/1 NaOH	Slight trace
9.	2·00	0·0000100	4	1 cc. N/1 NaOH	Mere trace
The above tests show the sensitiveness without interfering substances present, and also how sodium chloride interferes when present.					
10.	2·00	0·0000050	2	5 cc. $Ba(OH)_2$	No test
11.	2·00	0·0000100	4	1 cc. N/1 NaOH	Mere trace
12.	2·00	0·0000100	2	Salt from 1 cc. N/1 NaOH	Mere trace
13.	2·00	0·0000150	2	Nothing	Good test
14.	2·00	None added	2	Salt from 1 cc. N/1 NaOH	Trace
15.	2·00	0·0000100	10	Salt from 1 cc. N/1 NaOH	Slight trace
16.	2·00	0·0000200	2	Salt from 1 cc. N/1 NaOH	Slight trace
17.	2·00	0·0000200	10	Salt from 1 cc. N/1 NaOH	Slight test
18.	2·00	0·0000250	2	Salt from 1 cc. N/1 NaOH	Slight test
19.	2·00	0·0000300	2	Salt from 1 cc. N/1 NaOH	Plain test
20.	2·00	0·0000100	2	15 grms. of sand + 2 cc. of curcuma solution	Faint test
The following tests were made at the ordinary temperature or not to exceed 40° C. Either a vacuum drier or an ordinary desiccator was used. V = vacuum drier and D = desiccator.					
21. V	2·00	0·0000100	2	Salt from 1 cc. N/1 NaOH	Strong test
22. V	2·00	0·0000010	2	Salt from 1 cc. N/1 NaOH	Plain test
23. D	1·00	0·0000010	1	Nothing	Strong test
24. D	0·10	0·0000001	½	Nothing	Plain test
25. V	10·00	0·0000100	1	1 cc. saturated solution Na_2CO_3 ..	Strong test
26. V	10·00	0·0000100	1	1 drop of syrupy phosphoric acid ..	Strong test
27. V	10·00	0·0000100	1	1 cc. potassium nitrate solution ..	Strong test

Distil off the alcohol carefully, and run a blank through the apparatus (putting alkali in the boiling flask), and see if there is any titratable amount of boric acid given off. If not, the alcohol is all right. Where the alcohol is to be used to collect the boric acid for a subsequent qualitative test, it must be purified till 100 cc. of distillate give no test for boric acid qualitatively.

Effect of Methyl Alcohol on p-*Nitrophenol and on Phenolphthalein.*—The alcohol recently distilled from an excess of alkali is meant in all cases. 100 cc. of the alcohol were taken, and one drop of the nitrophenol indicator added. The colour was yellow. N/10 sulphuric acid was run in till the solution was colourless. 0·90 cc. was used. One drop of N/1 sodium hydroxide brought back the yellow very strong. Experiment repeated except N/1 sulphuric acid was used. Result the same, two drops = 0·10 cc. being used. This relationship between one drop of nitrophenol and methyl alcohol holds roughly for various dilutions, and a delicate method of testing for acidity in methyl alcohol might be arranged from this fact. In our case all we wanted was to make sure that we could titrate the mineral acid in the methyl alcohol distillate fairly close, and this is demonstrated.

Phenolphthalein is of little use in titrating acidity in methyl alcohol. Great dilution is necessary before the indications are good. But after the alcohol is made neutral or slightly alkaline (after previously being acid) to nitrophenol, then phenolphthalein may be depended on to indicate pretty closely the end-point for a boric acid titration.

Indicators.—Phenolphthalein is made up by dissolving 5 grms. in 500 cc. of ethyl alcohol, and making up to 1 litre. Use about 1 cc. in tests.

p-*Nitrophenol.*—This indicator was ordered as nitrosophenol, and came marked as nitrosophenol, but as it fails to give Liebermann's reaction for nitroso compounds, and has a melting-point of about 113° it must be simply *p*-nitrophenol and not the nitroso-compound.

Make up by dissolving 1 grm. in 75 cc. of neutral ethyl alcohol, and add 25 cc. of water. Use 1 drop to 100 cc. of the solution to be titrated. As this indicator is, perhaps, not well known I will give its properties as I have found them. My attention was first called to this indicator by an article by L. Spiegel in the *Journ. Chem. Soc. Ind.* (1900, xix., 1049). He recommends it to replace methyl-orange. I can corroborate his statement, and also those he makes in the same journal (xxiii., 682), where he takes issue with Lunge on its being able to replace methyl-orange for many titrations. This indicator is about as sensitive as phenol phthalein. Colourless with mineral acids and intensely yellow with caustic or carbonated alkalis. With bicarbonates the yellow shade is much weaker, but still bicarbonates can be titrated, if care is used. In boric acid titrations, avoid carbonates as much as possible. If 100 cc. of water is made just alkaline to nitrophenol, on adding glycerol the solution becomes colourless when boric acid is present, though boric acid gives no indication in aqueous solution, unless it is a strong solution, in which case even methyl-orange will react acid. No distinct end-point can be obtained with nitrophenol in the presence of glycerol and boric acid. As the boric acid comes nearer to $NaBO_2$ the colour of the solution becomes more intensely yellow, and this acts as a guide to the phenolphthalein end-point.

Methyl-orange.—One grm. dissolved to 1 litre in water. It may be used in place of nitrophenol in aqueous solution, but not in methyl alcohol. It has the advantage over nitrophenol of being less sensitive to carbonic acid (though it is by no means entirely indifferent to this acid), and also less sensitive to boric acid in a strong aqueous solution. Its disadvantages are that it is not nearly as sensitive as nitrophenol, and the end-reactions run through several shades of colour, and it cannot be used in methyl alcohol with any accuracy. I seldom use it for boric acid titrations.

We have found that methyl-orange and nitrophenol give he same end-points in titrating sodium hydroxide or ammonia. Remember always that the colour is much weaker in the presence of bicarbonates.

In the absence of interfering agents and complete absence of carbonic acid, phenolphthalein, methyl-orange, and nitrophenol in aqueous solution will give identical end-points.

(To be continued).

ON THE ELEMENTARY NATURE AND ATOMIC WEIGHT OF TELLURIUM.*

By JAMES F. NORRIS.

Some years ago Norris, Fay, and Edgerly undertook a study of the elementary nature of tellurium in order to discover, if possible, the cause of the anomalous relation of the element to the periodic law (*Am. Chem. Journ.*, xxiii., 105). Up to the time of the publication of the work reported by them, no systematic study of this problem had been described. A number of investigators had determined the atomic weight of tellurium, after what appeared to be a careful purification of the compounds to be analysed. The methods of purification used, however, were not of such a nature as to be relied upon to free the compounds investigated from undiscovered elements. With this fact in mind an investigation was undertaken. Since the work was started great activity has been shown in this field, and a number of papers have appeared on the atomic weight of tellurium. The most noteworthy is that of Köthner, to which the reader is referred for a full historical account of the subject (*Ann.*, cccxix., 1).

The work about to be described was inspired by a statement in the Faraday memorial lecture delivered by Mendeléeff in 1889. In discussing the periodic law Mendeléeff recounts the great service which the law has rendered in bringing about the correction of a number of atomic weights. In seeking to explain the high value of the atomic weight of tellurium, he expresses the opinion that the so-called element consists of two elements: one, true tellurium with an atomic weight of approximately 125, and the other, an element with a higher atomic weight, which would find a place in the periodic classification in the vacant space under tellurium. To this undiscovered element Mendeléeff gives the name dvitellurium. He sketches the chemical and physical properties of such an element, as he had already done so successfully in other cases.

It was to test this hypothesis that the work which has been published and that described below were undertaken. In order to make the study of the problem complete it seemed necessary to endeavour to discover, first, whether an undiscovered element, which did not belong to the sulphur group, was present in tellurium, and, second, whether the hypothesis of Mendeléeff could be given any experimental basis.

In seeking a solution of the first problem, a sample of tellurium, which had been freed from all known elements, was converted into a compound of the formula $Na_2S_4TeO_6$. This substance is a derivative of sodium pentathionate in which one sulphur atom has been replaced by one of tellurium. From this compound the tellurium was recovered by means of a reaction which is characteristic of pentathionates. Determinations of the atomic weight of the tellurium, which had been purified in this way, gave as a mean from several experiments the value 127·46. (For the atomic weights used in the calculation see *prox.*; if no vacuum correction is made and 14·04 is taken as the atomic weight of nitrogen this value becomes 127·62). This number was identical with that obtained with a sample of the element which had not been subjected to this particular method of treatment. As it is improbable that an element not in the sulphur group would show the

* From the *Journal of the American Chemical Society*, xxviii., No. 12.

power to replace, in part, sulphur in such a characteristic compound as sodium pentathionate, the conclusion can be drawn that tellurium contains no element which does not show the characteristic reactions of the sulphur group.

In order to test experimentally the hypothesis of Mendeléeff, carefully purified compounds of tellurium were subjected to fractionation. In the paper already published an account is given of the study of the products resulting from a fractional crystallisation of the double bromide of tellurium and potassium. Atomic weight determinations of the element obtained from these products agreed with one another within the limits of accuracy of the method used. Notwithstanding this result the work was continued, as it was thought that the breaking down of the salt by crystallisation might not have been effected on account of the fact that its constituents were isomorphous with each other. The method described below, which was finally selected to test the question, involved the study of the products resulting from the fractional distillation of tellurium dioxide.

Other investigators have used compounds which have been distilled. Brauner used sublimed tellurium tetrabromide in one of his atomic weight determinations. As the difference between the boiling-points of the bromides of selenium and tellurium is not great, it is evident that a long-continued process of fractionation would be necessary to free tellurium bromide from the analogous compound of dvitellurium. Since this work was started Köthner has determined the atomic weight of distilled tellurium. The difference between the boiling-points of selenium and tellurium is such that it would be reasonable to expect that another element in the same family with a higher atomic weight would have a boiling-point not far from that of tellurium. It appeared from the above-mentioned facts that it was worth while to re-study the problem if a better method could be found. The properties of the oxides of sulphur, selenium, and tellurium are such, that it seemed that a study of tellurium dioxide would give results which would furnish a definite answer to the question as to the elementary nature of tellurium. Sulphur dioxide boils at −8°, selenium dioxide is volatile at 200—250°, and tellurium dioxide is converted into vapour slowly at a bright red heat. In the light of these facts it is highly probable that the oxide of another element in the same family, with a higher atomic weight, would be very much less volatile than is tellurium dioxide, if volatile at all at the temperature of the Bunsen flame.

The oxide investigated was prepared from a sample of nitrate which had been carefully purified. The source of the material and the methods of preparation and purification used are described in detail in the paper cited above. In the distillation of the oxide the process was stopped after about three-quarters of the product had been volatilised. The part which had distilled was re-distilled until, as before, three-quarters of it was collected. This process of fractionation was repeated five times. The oxide was distilled from platinum at the highest temperature obtainable with a Bunsen burner; under these conditions the oxide was collected at the rate of about 0·15 grm. per hour.

The atomic weights were determined of the tellurium in the first residue, which should have contained the less volatile oxide, and of the tellurium in the oxide which had been sublimed five times. As a standard for comparison the atomic weight of the tellurium in a sample of oxide which had not been sublimed was determined. The method of determining the atomic weight which was used was that first described in the paper by Norris, Fay, and Edgerly, already cited, namely, the conversion of the nitrate into the oxide. This method has recently been used with success by Köthner.

The results were as follows:—The average atomic weight obtained in the case of the tellurium from the undistilled oxide was 127·50. The average of three determinations of the value, when the oxide which had been distilled five times was used, was also 127·50. The original residue from the first fractionation gave the atomic weight 127·46. It is evident from these results that the fractional distillation effected no decomposition in the tellurium dioxide. The mean of all the values for the atomic weight agrees well with the most trustworthy determinations which have been published, when these are calculated on the same basis.

The results seem to the writer to furnish positive evidence in favour of the elementary nature of tellurium. With a difference of about 250° between the boiling-points of sulphur dioxide and selenium dioxide, and a difference of 500° to 600° between the same constants for selenium dioxide and tellurium dioxide, it is evident, from all analogies in the properties of compounds of members of the natural families in the periodic classification, that the oxide of an element, which should find its place in the formulation of the law in the vacant space under tellurium, should be very much less volatile than tellurium dioxide. Its separation by the process used should have been at least in part effected. Even if tellurium contains an element which does not belong to the sulphur family, the possibility of its oxide having the same volatility as that of tellurium dioxide is very remote. As there was no evidence of even the slightest change in the properties of the compound, or in the atomic weight as a result of the tests applied, and as these tests seem to be reliable and well suited to answering the question, the conclusion can be drawn that the statement that tellurium is an element rests upon a firmer experimental basis than heretofore.

Experimental.

The source and preliminary purification of the material used in this investigation are described at length in the paper already cited. A sample of the basic nitrate of tellurium, which had been re-crystallised three times from nitric acid, was made use of in the work. From this the oxide was prepared by heating at increasing temperatures until all nitric acid had been removed.

About 25 grms. of the oxide were fractionally distilled. The point at which tellurium dioxide volatilises is so high it could not be distilled in a tube in the usual way. After tests of a number of methods that selected was as follows:—The oxide was heated to bright redness in a platinum crucible, over which was placed a funnel with the stem bent at right angles. To this last was attached a glass tube provided with a cork and an exit tube, the open end of which was covered with filter-paper. A rapid stream of air was drawn through the tube and funnel. The tellurium dioxide which had been vaporised was swept through the funnel, and was collected as a fine powder, which settled in the tube and on the paper which covered the exit from the tube. When the crucible, which contained the oxide, was heated to bright redness, between 0·1 and 0·2 grm. of the oxide distilled in one hour.

The distillation was started with about 25 grms. of tellurium dioxide. This was heated until a residue of 7 grms. remained. The 18 grms. which had been vaporised were again distilled until there was a residue of about 3 grms. The twice distilled oxide was re-distilled until about 12·5 grms. had been collected. The process was repeated and 8 grms. were distilled off. In the fifth distillation the oxide which was collected weighed about 6 grms. The fractions of the oxide resulting from the distillation were converted into the basic nitrate, re-crystallised twice from nitric acid, and finally purified for analysis as described below.

(The author gladly acknowledges his indebtedness to Mr. C. F. Swan, of the Massachusetts Institute of Technology, who carried out the fractioning of the oxide, which was a tedious process, requiring a very long time for its completion).

In endeavouring to test the question whether tellurium contains an unknown element which does not belong to the sulphur group, another method of purification was made use of. Facts which were reported by Norris and Fay in their papers on the volumetric estimation of

selenium and tellurium suggested a convenient way of attacking this problem. It was shown that a reaction represented by the following equation takes place when selenium dioxide, sodium thiosulphate, and hydrochloric acid are brought together in aqueous solution:—

$$SeO_2+4Na_2S_2O_3+4HCl=Na_2S_4O_6+Na_2S_4SeO_6+4NaCl.$$

The selenopentathionate is very unstable and cannot be obtained from solution. That the salt was present was shown by the fact that the solution exhibited all the reactions which are characteristic of pentathionates. Sodium pentathionate is stable in an acid solution, but is instantly decomposed when brought into contact with alkalis, being converted into sodium tetrathionate and free sulphur. The analogous selenium compound suffered decomposition in the same way, and was converted into the tetrathionate and selenium.

It was also shown that similar reactions take place when the product of the reaction between tellurium dioxide, sodium thiosulphate, and hydrochloric acid is treated with alkalis. A sample of pure tellurium dioxide was converted into the pentathionate derivative, which was then treated with sodium hydroxide. It seemed highly probable that the precipitated teliurium so obtained was free from any element which did not have the power to replace sulphur in a pentathionate. The precipitate was treated with hydrochloric acid to free it from any hydroxide that may have been thrown down by the alkali.

In order to carry out the reaction successfully the substances are brought together in the quantities required by the chemical equation, with the exception that more hydrochloric acid than is called for must be used in order to keep the tellurium dioxide in solution. The solution must be dilute and cold in order to prevent decomposition of the sodium thiosulphate by the excess of acid. Addition of a small quantity of alkali to the acid solution causes the precipitation of a part of the tellurium present. This precipitation continues until the solution is rendered alkaline. The tellurium obtained in the way outlined above was converted into the basic nitrate, which was crystallised twice and finally prepared for analysis.

In the final purification of the nitrate it was crystallised from dilute nitric acid (sp. gr. 1·25), which was prepared from purified materials. The water used for dilution was twice distilled, the last time from alkaline permanganate. The nitric acid used was a good sample of chemically pure acid, which was re-distilled slowly from a platinum still, provided with a platinum condenser and receiver. The diluted acid was kept in bottles which had been repeatedly treated with warm nitric acid. The salt was crystallised in porcelain dishes which had been carefully cleaned with hot acid. Saturated solutions of the salt were evaporated at about 85° until reduced to about one-fourth their original bulk. The hot mother-liquor was immediately removed, and the crystals were washed with re-distilled concentrated nitric acid. The crystals were again dissolved in the purified acid, and re-crystallised.

It was found necessary, in order to obtain concordant results, to use, in determining the ratio between the weights of nitrate and oxide, only crystals which had been formed during the evaporation. In every case where the mixture of crystals and mother-liquor was allowed to stand over night before the crystals were removed, low values of the atomic weight, which varied with different samples, were obtained. It was evident that spontaneous evaporation caused the formation of crystals which contained mother-liquor.

The crystals which were removed from the hot solution were washed a number of times with re-distilled concentrated nitric acid, and were then ground to a very fine powder in an agate mortar, while still moist with acid. The finely ground nitrate was transferred by means of a platinum spatula to a well-cleaned porous tile, which immediately removed most of the acid clinging to the powder. The tile, with the nitrate which had been placed on it in a small pile, was placed in a desiccator which contained concentrated sulphuric acid and solid potassium hydroxide. The air was exhausted from the desiccator, which was left undisturbed for a day. The nitrate was then removed from the tile, care being taken to reject the portion which had come in contact with the tile. The product, which was at this stage in the form of a hard lump, was readily reduced to a find powder by breaking it with a few strokes of a spatula. The nitrate was next kept for at least three days in a vacuum over phosphorus pentoxide.

This method of removing the excess of acid liquid from the nitrate is an improvement over that used by Köthner in his work. Köthner was of the opinion that as the acid was removed by evaporation from the crystals, they were partially decomposed to the oxide with loss of acid. This may have been the case when the acid was removed at an elevated temperature as Köthner did it. In order to prevent this decomposition he washed the crystals with mixtures of nitric acid and alcohol, using successively a larger proportion of alcohol in the mixture until pure alcohol was used. This method is tedious, and great precautions are necessary. In the preliminary work a number of samples were prepared by Köthner's method. These gave the same results as samples prepared as described above.

In determining the ratio between the weights of the nitrate and oxide the usual precautions necessary for accurate results were taken. The weights were calibrated and a balance sensitive to 0·03 mgrm. was used. The weighings were made by substitution after the crucibles had stood in the balance case at least two hours. A crucible like those used to contain the nitrate was used as a tare.

The samples of nitrate were heated in platinum crucibles to constant weight at 140° in a current of air dried by passing over phosphorus pentoxide. The first heating of the salt, which brought it to constant weight, was continued for four hours. The samples were weighed before and after this heating at 140°. In no case was the loss in weight as a result of heating for four hours greater than 0·1 mgrm. The decomposition of the nitrate was brought about slowly in order to avoid the loss of tellurium dioxide by mechanical removal along with gases evolved. The crucibles were heated about six hours at 250°, six hours at 300°, three hours at 350°, three hours at 400—450°. The crucibles, resting on pieces of platinum-foil inside a large covered porcelain crucible, were next heated for four hours at the highest temperature procurable with a Bunsen burner. The oxide formed from the nitrate in this way was finally fused by the application of a free flame for a few seconds. A test showed that the oxide contained no nitric acid, and the glassy condition produced by the fusion precluded the possibility of any enclosed gases.

The results of the analyses follow:—

No.	Weight $2TeO_2.HNO_3$.	Weight TeO_2.	Atomic weight.
1.	2·28215	1·90578	127·47
2.	2·35429	1·96615	127·53
3.	1·86853	1·56042	127·49
4.	1·77348	1·48110	127·49
5.	2·31048	1·92938	127·44
6.	2·14267	1·78936	127·50
7.	2·35523	1·96676	127·45
8.	2·18860	1·82780	127·54
9.	3·29158	2·74881	127·50
10.	2·27516	1·89993	127·46
11.	2·53164	2·11410	127·46
12.	2·01327	1·68121	127·45
		Average	127·48

In the second and third columns are given the apparent weights of the nitrate and oxide. In calculating the values of the atomic weight, a vacuum correction was made of +0·150 mgrm. for each grm. of nitrate and +0·066 mgrm. tor each grm. of oxide. The specific gravity of tellurium dioxide has been reported as 5·76. The value of this con-

stant for the basic nitrate of tellurium was found to be 4·26 at 22°/4°. The atomic weights used in the calculation were H, 1·0076; N, 14·01; O, 16.

When the results are calculated in the manner used by Köthner,—namely, H, 1·01; N, 14·04; O, 16,—and no vacuum corrections are applied, the average is 127·64. Kothner's average is 127·63.

The results given under Nos. 1, 2, and 3 were those obtained with a sample of nitrate which had been purified by crystallisation only. In the paper by Norris, Fay, and Edgerly it was stated that crystallisation of the basic nitrate served to purify it from all other metals. These results confirm that statement. Köthner showed by a spectroscopic examination that the nitrate prepared by him contained silver and gold. When he determined the atomic weight of tellurium, using a sample of nitrate made from the metal which had not been distilled, he obtained as the atomic weight the value 127·36, which differed by 0·27 unit from the value found when distilled tellurium was used. He considered the cause of this difference to be the presence of silver and gold in the nitrate which was prepared from undistilled tellurium. The results given above, which were obtained with a sample of nitrate which had been purified by crystallisation alone, are practically identical with those obtained from a sample of nitrate prepared from the oxide which had been five times distilled.

The results obtained with the nitrate prepared from the tellurium which had been converted into the telluropentathionate are recorded in experiments numbered 4, 5, and 6. In the experiment numbered 7 the nitrate used was prepared from a sample of oxide which had been distilled but once, while in experiments 8 and 9 the oxide from which the nitrate was made had been distilled five times. In Nos. 10, 11, and 12 are recorded the results of the analyses of samples of nitrate prepared from the residue from the first distillation. If the dvitellurium of Mendeleeff had been present, the atomic weight of this fraction should have been much higher than 127·48.

The results show clearly that the application of the methods studied effected no decomposition of tellurium. As these methods would have shown the presence of an unknown element with the properties which have been assigned to dvitellurium by Mendeleeff, the conclusion can be drawn that no such element is present. The work adds to the experimental evidence in favour of the elementary nature of tellurium.

The atomic weight found agrees well with the most reliable values which have been determined by others.

PROCEEDINGS OF SOCIETIES.

FARADAY SOCIETY.

Ordinary Meeting, January 15th, 1907.

Sir JOSEPH SWAN, F.R.S., Past President, in the Chair.

MR. E. E. FOURNIER D'ALBE read a paper and opened a general discussion on "*The Application of the Electron Theory to Electrolysis.*" (See CHEMICAL NEWS, vol. xcv., p. 28).

Mr. JOHN G. A. RHODIN considered that the electron theory, like the atomic theory, merely complicated matters and was unnecessary. The conception of infinite divisibility was a necessary one in physics as in mathematics, if our reason was to be satisfied. Both in chemistry and physics we know of mathematical relations only, and hypotheses are only crude images. The ether and electrons were invented because certain phenomena could be the more easily treated mathematically by means of these conceptions. A simple theory of ions was all that was necessary for understanding electrolysis; more hypotheses were not wanted. Existing theories left many well known facts without explanation. He suggested the appointment of an International Committee for generalising existing theories, and making them available to the average intelligence.

Dr. H. BORNS asked whether the Hall effect and the recent experiments of Kaufmann did not throw some doubt on the electron theory. Why were there no free electrons in liquids?

Dr. J. A. HARKER was not clear as to whether the theory supposed atoms to be composed entirely of electrons or whether there was a central nucleus. If the former, one would expect more intermediate formations. He thought the fundamental conceptions of the theory should be made perfectly clear, so that the explanations of various phenomena given by it could be deduced from some simple postulates.

Dr. T. M. LOWRY pointed out that much of the work on hydration asked for by the author had been carried out, among others, by Biltz, Jones, and Bousfield. The latter had shown, for example, that the chlorine ion attached five water molecules to itself.

Mr. N. T. M. WILSMORE considered that the theory, which looked upon electrons as exerting a sort of osmotic pressure at the surface of an electrode, conceived admirably the mechanism of electrode potential and of electrode reactions. It was noteworthy that the more electropositive a metal, the more easily it threw off electrons under the stimulus of ultra-violet light, for example. He showed how the theory explained, in a simple manner, oxidation and reduction phenomena, and the action on the positive accumulator plate. He thought that the negative electron should have a distinctive name, and proposed using the word "negatron," which had been suggested.

Mr. F. KAYE remarked on the simple explanation of the different mobilities and therefore hydrations of the various ions on the view that the positive and negative ions acted to different degrees as condensation nuclei. He asked whether when a liquid was evaporated there was a movement of electrons into the vapour.

Mr. F. S. SPIERS pointed out that the theory did not seem to help in explaining the fundamental preliminary to electrolysis, namely, dissociation in solution.

Mr. E. E. FOURNIER D'ALBE replied to the various speakers. He did not think that the few considerations put forward by Mr. Rhodin overthrew the theory. The difficulty of the Hall effect mentioned by Dr. Borns was more serious, but the negative swing that had been observed might be due to positive ions of great mobility, and not necessarily to the existence of positive electrons. A similar recent observation of the Faraday effect could be similarly explained. Kaufmann's experiments dealt with structure of electrons and merely pointed to Abraham's theory of a rigid electron being more probable than Lorentz's, which, in order to account for the Michelson-Morley experiments, supposed the electron to become shortened in its passage through the ether. Their great mobility in face of little resistance would prevent free electrons existing in liquids. When a metal was liquefied, probably polymerisation took place, and ions were formed which carried the current.

In reply to Dr. Harker, it seemed that atoms most likely consisted of negative electrons whirling round a positive nucleus. The solar system presented a close analogy. Only certain configurations would be stable; hence every intermediate stage of element would not persist. The theory at present could not be built up from simple postulates; it was in the induction stage, and kept in close contact with facts.

In reply to Mr. Kaye, electrons did not pass into the vapour from a boiling liquid; the surface of the liquid was a perfect semi-permeable membrane.

The CHAIRMAN, in moving a vote of thanks to the author for his important and interesting paper, which had stood so well the trying ordeal of some trenchant criticism, referred to the inadequacy of the old ideas to account completely for all the phenomena of conduction,

electrolytic and other, ideas which he none the less found it not easy to get rid of, without at least some further consideration.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. clxiv., No. 2, January 14, 1907.

Apparatus for the Preparation of Pure Oxygen Utilisable in Organic Analysis.—A. Seyewetz and M. Poizat.—This is a method for producing a continuous supply of pure oxygen under a pressure sufficiently constant to admit of its taking the place of a gasometer. The method turns upon the reaction of permanganate of potassium with hydrogen peroxide. After operating in acid, neutral, and alkaline solution respectively, it was found that in the acid medium the best results were obtained. Whether the hydrogen peroxide was allowed to drop into the solution of permanganate or *vice versâ* was found to be immaterial, but it was an indispensable condition that the solution which dropped into the other should be the denser; otherwise the two liquids did not mix or react well together. This condition is always fulfilled by mixing the acid necessary to the reaction with the flowing solution. About 10 litres of oxygen were thus obtained for 500 cc. of water oxidised to ten volumes. The only impurities contained in the oxygen were traces of chlorine and ozone. The chlorine was removed by passing the gas through potash solution. The authors found that the use of this apparatus gave excellent results in connection with organic combustions, making the use of a gasometer quite dispensable.

A Case of Isomerism in the Oxygen Combinations of Grignard and Baeyer.—W. Tschelinzeff.—There are two different structures attributed to the complex molecules formed by ether and the organo-magnesium compounds, one of which $\begin{matrix}R\\R\end{matrix}\!>\!O\!<\!\begin{matrix}X\\MgR'\end{matrix}$ was proposed by Baeyer, and the other, $\begin{matrix}R\\R\end{matrix}\!>\!O\!<\!\begin{matrix}R\\MgX'\end{matrix}$ by Grignard. The author affirms that most of the observed facts point to the former as being the correct structure, *e.g.*, from the analogies presented by these bodies with ammoniacal compounds, and the combinations formed by the action of the ethers upon the halogen acids, as well as their peculiar activity in relation to different carboxyl combinations having the same radical as the iodide. Baeyer's interpretation admits of possible interesting isomers theoretically, such as the following :— $\begin{matrix}R\\R\end{matrix}\!>\!O\!<\!\begin{matrix}X\\MgR'\end{matrix}$, and $\begin{matrix}R'\\R'\end{matrix}\!>\!O\!<\!\begin{matrix}X\\MgR'\end{matrix}$, which would not be distinct bodies according to Grignard's arrangement. From experiments on the decomposition of these substances by water the presence of an isomer is demonstrated. The author has investigated thermochemically the decomposition by water of certain of those combinations as a means of determining the influence exerted by the position of the radical upon the bonds uniting the atoms. The results of the researches showed that the thermal effects differed too slightly for any conclusion to be formulated from them as to the isomerism of bodies in question; but it was proved beyond doubt that the ether-organo-magnesium compounds are manifested in isomeric forms, according to the nature of the bodies serving as the point of departure.

The Superoxide of Methylethylketone. — M. Pastureau.—For acetones of the fatty series it is a general fact that hydrogen peroxide, in presence of an acid catalyser, gives with dimethylketone a superoxide, $(C_3H_6O_2)_2$, and an acetone-alcohol, the acetol $C_3H_6O_2$. The author has isolated the superoxide $(C_4H_8O_2)_2$ from the methylacetol, or acetylmethylcarbinol, $C_4H_8O_2$, produced by the action of hydrogen peroxide upon methylethylketone in presence of sulphuric acid. The superoxide is an oily colourless liquid, of agreeable odour, quite stable at the ordinary temperature, but explosive when heated above 100°; insoluble in water, soluble in alcohol, ether, and benzene; density at 15°, 1·042. *Analysis.*—Found (per cent)—C, 54·2; H, 9·4. Calculated for $C_4H_8O_2$ (per cent)—C, 54·54; H, 9·09. The molecular weight, determined by the cryoscopic method with benzene as solvent, corresponds to the formula $(C_4H_8O_2)_2$. Its chemical properties are those of a superoxide.

Berichte der Deutschen Chemischen Gesellschaft. Vol. xxxix., No. 17, 1906.

Colbatic Molybdates.—Carl Friedheim and F. Keller.—The cobaltic molybdates, unlike the similar cobaltous compounds, give off chlorine when boiled with hydrochloric acid. They are green in colour, and are formed when mixtures of cobaltous acetate and ammonium or potassium paramolybdate, $3R_2O_7.7MoO_3$, are treated with persulphate or hydrogen peroxide, or when ammonium permolybdate, $3(NH_4)_2O.5MoO_3.2MoO_4.6H_2O$, acts on cobaltous acetate. Generally speaking, the solutions are mixed in the cold and then more or less strongly heated. The colour then changes from pink to green, oxygen escapes, and some insoluble cobaltous molybdate separates out, while the cobaltic molybdate can be obtained from the liquid by crystallisation. The compounds which the authors have prepared are:—

$3BaO.CoO.CoO_2.9MoO_3$,
$2(NH_4)_2O.CoO.CoO_2.10MoO_3$.
$2BaO.CoO.CoO_2.10MoO_3$.
$3K_2O.CoO.CoO_2.10MoO_3$.
$3(NH_4)_2O.CoO.CoO_2.12MoO_3$.
$3K_2O.CoO.CoO_2.12MoO_3$.

Preparation and Properties of Antimony Pentafluoride.—Otto Ruff.—Hydrofluoric acid is condensed by a good cooling mixture in a platinum retort, and cooled antimony pentachloride is added, taking special precautions to ensure the presence of a large excess of the acid. This is necessary because the antimony pentafluoride formed gives a fluorhydrate with hydrofluoric acid, and this reacts much more slowly with the pentachloride, and is only decomposed into its constituents at a high temperature. The hydrofluoric acid must be completely removed before the antimony pentafluoride can be distilled off. Moreover, the yield may be greatly affected by the presence of potassium fluoride in the acid, which must therefore be first purified. As regards the chemical properties of the pentafluoride, with chlorine it gives no fluorine; with bromine it gives a tarry dark brown mass, which contains a compound SbF_5Br; with iodine it yields $(SbF_5)_2I$ and SbF_5I; with sulphur it forms a blue solution from which SbF_5S can be isolated. It is indifferent towards most dry metals, and in dry air and in dry carbon dioxide it sublimes without leaving any residue. On the addition of water it passes over into the solid hydrate, $SbF_5.2H_2O$, and with more water it gives a clear solution which is not decomposed on boiling. The solution, when mixed with sodium carbonate or caustic soda solution, yields acid sodium pyrantimoniate quantitatively. When the aqueous solution is evaporated a hydrate of antimony pentafluoride is first left, and after heating *in vacuo* this leaves, finally, antimonic acid. In a current of sulphuretted hydrogen, sulphur, hydrofluoric acid, antimony sulphofluoride and antimony trifluoride are formed. The author has also investigated its behaviour with many other inorganic and organic compounds. Of the latter, wood, cork, and rubber are all strongly attacked; benzene and ether react with it vigorously, and carbon tetrachloride yields $C.Cl_3F$. When the actions of the halogens and sulphur on antimony pentafluoride were examined quantitatively, it was found that it reacted most

vigorously with chlorine, and then with bromine, iodine, and sulphur in the order as given. With antimony trifluoride it forms stable compounds of the empirical composition $SbF_5.2SbF_3$ to $SbF_5.5SbF_3$. When dry ammonia gas is led over SbF_5 a reaction occurs, and much heat is evolved. The pentafluoride becomes covered with a thick yellowish red incrustation, which soon stops further action. The effect of liquid ammonia was therefore investigated, and a new compound was thus isolated. It has the formula $SbF_3.(NH_3)1\frac{1}{2}$ or $Sb_2F_8.(NH_3)_3$, and is the difluorhydrate of diamidodiantimony fluorimide. The boiling-point of antimony pentafluoride the author finds to be 149—150°.

Violet and Green Chromium Chloride.—F. Jost.—The author has determined the position of the six molecules of water in the chromium chlorides by finding the properties of the salts in a solvent in which there can be no doubt about the method of combination of the water. He chose methyl alcohol as solvent, and measured the lowering of the tension and the conductivity of the two salts. His experiments prove that in the green hydrate the water is more loosely held, for a lowering of the tension was found, which shows that on dissolving a molecule of the green hydrate eight active molecules are formed in the solution, while with the violet salt only four or five are formed, although the number of ions is less in the former case. In both cases the lowering of the tension was greater than was to be expected according to Werner's co-ordination formulæ :—

$[Cr(OH_2)_6]Cl_3$ — Violet chloride.

$\left[Cr<^{(OH_2)_4}_{Cl_2}\right]Cl$ — Green chloride.

This is to be explained by supposing that even in the nucleus water molecules are replaced by the molecules of the solvent. On evaporating the solution in methyl alcohol the salts would not crystallise out again.

New Method of Reduction (I.).—Th. Weyl.—Pure red phosphorus on being boiled with water or alkali gives large quantities of phosphoretted hydrogen. This is also the case when acids, *e.g.*, hydrochloric or sulphuric acid, act upon red phosphorus, and, moreover, the nascent PH_3 thus evolved may be used as a reducing agent. Its action was investigated quantitatively by allowing red phosphorus and water to act upon nitrobenzene in a closed vessel at 100°. The aniline thus formed was then determined; it amounted to 86 per cent of the theoretical yield, under favourable conditions. Apparently in the first stage of the reaction phosphoretted hydrogen results, and then reduces the nitro-group as shown by the equation $3C_6H_5.NO_2 + 4PH_3 \rightarrow 3C_6H_5NH_2 + 2H_3PO_3 + 2P$. In the second stage the phosphorus which separates yields fresh PH_3 with the water, and this then reduces a further quantity of nitrobenzene. According to the equation, roughly, 35 grms. of phosphorus would be required for the reduction of 100 grms. of nitrobenzene, and half of it, viz., 17·5 grms., would be recovered. But the great excess of water attacks the unused phosphorus according to the equation $4P + 6H_2O = 3H_3PO_2 + PH_3$, and secondary reactions also occur.

Reduction of Nitrobenzene by Aliphatic Alcohols in Light.—Giacomo Ciamician and P. Silber.—It is known that nitrobenzene is reduced by a fatty alcohol (not methyl) according to the following scheme:—$C_6H_5.NO_2 \rightarrow C_6H_5.NH.OH \rightarrow C_6H_5NH_2$. As to the fate of the alcohol it was supposed that it formed the corresponding aldehyde and then combined with the aniline to form the corresponding quinoline bases, which are found in the products of the reaction. To show that these quinoline bases are not formed from the aniline by the action of light, a mixture of aniline and paraldehyde was exposed to light for a year, when it was found that the product consisted almost entirely of aniline picrate.

Cuprous Sulphate.—F. Foerster and F. Blankenberg.—It is known that copper is taken up by cupric sulphate solution yielding cuprous sulphate, until equilibrium ensues, as shown by the equation $2Cu^{\cdot} \rightleftarrows Cu^{\cdot\cdot} + Cu$. According to this, by the law of mass action at a given temperature, $\frac{(C_{Cu^{\cdot}})^2}{C_{Cu^{\cdot\cdot}}} = \text{constant}$. If it is assumed that the cuprous sulphate is completely dissociated, and the cupric sulphate is 17 per cent dissociated, the value of this constant is $0{\cdot}66 \times 10^{-6}$. Its value increases as the temperature rises. This holds for an acid solution. In solutions free from acid the formation of the cuprous salt is somewhat favoured by the great inclination of cuprous sulphate to undergo hydrolysis with separation of cuprous oxide:—$Cu_2SO_4 + H_2O \rightleftarrows Cu_2O + H_2SO_4$. The solution, however, is thus made acid, and the hydrolysis is finally stopped. The formula shows that as the concentration of the cupric salt increases that of the cuprous salt increases too. But as it is the second power of the cuprous ions which is proportional to the first power of the cupric ions, it follows that at a given temperature the total amount of copper ions present is greater the smaller the concentration of the copper ions in the solution. Thus, if we start with a complex cupric solution, the cuprous salt must be correspondingly concentrated. The ammonia compounds are very suitable to use to investigate this point. The authors have studied the effects of introducing ammonium cupric sulphate solution and copper-wire into glass tubes which are afterwards fused up, and has determined the point at which equilibrium ensues by immersing a platinum-foil as cathode, and copper-wire as anode, and passing a current through. Copper is separated owing to the two processes $Cu^{\cdot} + \ominus \rightarrow Cu$ and $Cu^{\cdot\cdot} + 2\ominus \rightarrow Cu$. If far more copper is separated by the current than in a coulometer in which the process $Cu^{\cdot\cdot} + 2\ominus \rightarrow Cu$ is proceeding, it shows that equilibrium has been reached. In the course of these experiments the authors have succeeded in obtaining crystalline cuprous sulphate in the form of an ammonia compound; the formula is $Cu_2SO_4.4NH_3.H_2O$. The salt is unstable, but when quite dry can be kept for some weeks in fused-up tubes at the ordinary temperature. With dilute sulphuric acid the crystals turn bright red, and give metallic copper and cupric salt. Possibly the other oxygen salts of the cuprous series can be crystallised in the form of ammonia compounds, and the authors have already obtained a crystalline compound of cuprous chloride with ammonia.

MISCELLANEOUS.

Institute of Chemistry.—*Past List of the January Examinations*, 1907.—Of eleven candidates who entered for the Intermediate Examination the following eight passed:—R. R. Bennett, A. G. Harrington, J. H. Lane, C. P. Matthews, B.Sc. (Lond.), A. Miller, M.B. (Lond.), Capt. I.M.S., P. Murphy, B. D. Porritt, and E. C. Ward. In the Final Examination for the Associateship (A.I.C.), of seven examined in the branch of Mineral Chemistry five passed—J. Dick, jun., C. M. W. Grieb, B.Sc. (Lond.), A. T. King, B.Sc. (Lond.), A. Lathwood, B.Sc. (Lond.), and J. F. Reid; of three examined in Metallurgical Chemistry two passed—H. G. Dale and R. F. Innes; of three in the branch of Organic Chemistry one passed—H. Stanley, B.Sc. (Lond.); and of ten (including one Associate) who entered in the branch of the Analysis of Food and Drugs, and of Water, including an Examination in Therapeutics, Pharmacology, and Microscopy, the following eight passed—T. R. Hodgson, B.A. (Cantab.), H. Hurst, B. R. James, J. D. Kettle, B.Sc. (Lond.), F. Maudsley, B.Sc. (Vict.), J. Thompson, Ph.D. (Heidelberg), W. A. Whatmough, A.I.C., and C. H. Wright, B.A. (Cantab.). The Examiners in Chemistry were Mr. W. W. Fisher, M.A. (Oxon.), F.I.C., and Dr. G. G. Henderson, M.A. (Glasgow), F.I.C. The Examination in Therapeutics, Pharmacology, and Microscopy was conducted by Dr. F. Gowland Hopkins, M.A. (Cantab.), F.R.S., F.I.C.

MEETINGS FOR THE WEEK.

MONDAY, 4th.—Society of Arts, 8. (Cantor Lectures). "Gold Mining and Gold Production," by J. W. Gregory.
—— Royal Institution, 5. General Monthly Meeting.
—— Society of Chemical Industry, 8. "Chemical Composition of some Motor Tyre Rubbers" and "Composition of some New Crude Rubbers," by P. Schidrowitz and F. Kaye.

TUESDAY, 5th.—Royal Institution, 3. "Survivals from the Past in the Plant World," by Prof. A. C. Seward, F.R.S.

WEDNESDAY, 6th.—Society of Public Analysts, 8.15. (Annual General Meeting). "Mineral Acids in Vinegar" and "Composition of English Fermentation Vinegar," by F. D. Ratcliff. "Detection of Cane-sugar in Milk," by W. H. Anderson.
—— Society of Arts, 8. "The Principles and Practice of Insurance, and their Modern Developments," by Thomas Emley Young, B.A.

THURSDAY, 7th.—Royal Institution, 3. "Standards of Weights and Measures," by Major Percy A. Macmahon, F.R.S.
—— Chemical, 8.30. 'Rapid Electro-analytical Deposition and Separation of Metals—Part I, The Metals of the Silver and Copper Groups and Zinc," by H. J. S. Sand. "The Alkaloids of Ergot," by G. Barger and F. H. Carr. "Influence of Substitution on the Formation of Diazoamines and Aminoazo-compounds—Part VI., The Partially Methylated 4:6-Diamino-*m*-xylenes," by G. T. Morgan and F. M. G. Micklethwait. "Reduction of Hydroxylaminodihydroumbellulone Oxime" and "The Constitution of Umbellulone—Part II., Reduction of Umbellulonic Acid," by F. Tutin. "Studies on Optically Active Carbimides—Part V., The Aryl Esters and the Amides of *l*-Menthylcarbamic Acid," by R. H. Pickard and W. Oswald. "Some Constituents of Natural Indigo," by A. G. Perkin and W. P. Bloxam. "Occurrence of Isatin in some Samples of Java Indigo," by A. G. Perkin. "Absorption Spectra of Benzoic Acid, the Benzoates, and Benzamide" and "Absorption Spectra of Phthalic, Isophthalic, and Terephthalic Acids—Phthalic Anhydride and Phthalimide," by W. N. Hartley and E. P. Hedley. $\alpha\alpha\gamma$-Trimethyl- and $\alpha\alpha\gamma\gamma$-Tetramethyl-tricarballylic Acids and $\alpha\Delta$-Dimethyl-butane $\alpha\beta\Delta$-Tricarboxylic Acid," by H. Henstock and C. H. G. Sprankling. "Reaction of certain Colouring-matters of the Oxazine Series," by J. F. Thorpe.

FRIDAY, 8th.—Royal Institution, 9. "Old English Poetry," by Prof. I. Gollancz, M.A., Litt.D.
—— Physical, 8. (Annual General Meeting). President's Address. "The Magnetic Fields and Inductive Coefficients of Circular, Cylindrical, and Helical Currents," by A. Russell

SATURDAY, 9th.—Royal Institution, 3. "Papal Deposing Power," by the Rev. William Barry, D.D.

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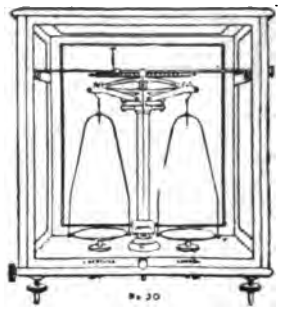

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THE limit of the test, as here arranged, is one drop or 0·05 cc. of N/10 sodium hydroxide solution. This corresponds to 0·00031 grm. of boric acid or 0·00062 per cent, or about 0·10 ounce per 100 pounds of the food product, a quantity absurdly small for any preservative effect.

The sample of meat or other food product is ground up or hashed, and 50 grms. of the well-mixed sample taken and placed in a clean cover of a three-pound lard pail, or other similar dish. Spread the meat in a layer over the dish and moisten with 25 cc. of N/1 sodium carbonate solution, or equivalent, and dry on the steam-bath, oven, or electric stove. It is a great advantage to dry before igniting, as by so doing the meat does not swell up, and burns off much easier. The quantity of sodium carbonate directed to be added is more than sufficient to retain 1 per cent of boric acid, and this is more than would be used. 25 cc. of N/2 sodium carbonate are generally sufficient, and makes the burning to carbonaceous ash quicker. Ignite gently, heating the whole bottom of the dish, if possible, to a carbonaceous ash free from brown products soluble in water. Do not burn off all the carbon. Allow to cool, and with a spatula scrape out the ash into a smooth mortar (a glass mortar is best). Grind up fairly fine and transfer from the mortar to the distillation flask. This is easily done, as the smooth mortar allows the ash to slide out completely. Put about 10 cc. of water into the dish from which the ash was scraped, add 1 cc. of strong hydrochloric acid, and allow to act about thirty seconds (we want to avoid dissolving the iron to any extent), and then pour into the distillation flask. This will sufficiently wash out the dish, and there would be no particular loss if this step was left out. About 3 to 5 cc. of strong hydrochloric acid are added to the distillation flask, and the ash allowed to soak in the liquid for a few minutes to dissolve as much as possible, the object being to get all the boric acid in solution. Ten to 15 grms. of dry, granulated, chemically pure calcium chloride are now added, and allowed to dissolve as much as will in a few minutes' shaking. Connect up the flask in its place in the distillation system and pass methyl alcohol vapour through. Usually no attempt is made to heat this flask except by the methyl alcohol vapour itself, but there is no harm in so doing after 50 to 100 cc. of the alcohol have condensed in it. When about 100 cc. of distillate has been obtained it is drawn off and tested. The distillation is allowed to go on without interruption, and each 100 cc. or less are drawn off and tested till no more boric acid is found. When the last distillate gives a test requiring only one drop of N/10 sodium hydroxide solution the process is generally assumed finished, as without great care the blank test on the glycerol alone or in the presence of salts will vary a drop. If necessary the determination can be made absolutely to within one drop of N/10 sodium hydroxide.

Each distillate is tested as follows:—It is drawn off into a flask similar to the distillation flask (a round-bottomed flask holding up to the neck about 275 cc.), and one drop of nitrophenol indicator solution added. N/1 sodium hydroxide solution is dropped in till the yellow colour of the indicator is seen. Practically all the mineral acid that has distilled over is now neutralised. Experiment shows that very little mineral acid does distil over, even with a large excess in the distillation flask, unless the contents of the distillation flask are concentrated. Now add about 1 cc. of the phenolphthalein indicator and run in N/1 sodium hydroxide solution till the pink colour is seen. As soon as you are sure the coloration is reddish or pink, that will do without making it strong. The difference between the end-points with nitrophenol and phenolphthalein will be a close measure of the boric acid present, as the methyl alcohol takes the part of glycerol, and would probably be just as good as the latter but for its peculiar effect on some indicators. After finding how many cubic centimetres correspond to the boric acid, add twice as much more alkali; that is, if the difference in end-points between nitrophenol and phenolphthalein was 10 cc. then add 20 cc. more of the alkali. This is to ensure enough alkali to combine with the boric acid to form Na_3BO_3, which is certainly enough to prevent loss of boric acid on evaporating off the methyl alcohol. In all probability this is more than enough. The compound or mixture of boric acid and alkali that is stable in boiling methyl alcohol is stated by E. Polenske (*Journ. Soc. Chem. Ind.*, 1901, xx., 273) to have the composition $5Na_2O.4B_2O_3$, and this is apparently a mixture of $NaBO_2$ and Na_2O. Now put a capillary boiling tube into the flask and evaporate off the methyl alcohol on the steam-bath. When the alcohol has evaporated, dissolve the residue in about 25 cc. of water, and run in N/1 sulphuric acid till the solution is colourless. If a large quantity of N/1 sodium hydroxide solution has been used, necessitating a large quantity of acid, it is better to drop in strong hydrochloric acid till the solution is colourless, thus keeping the bulk down. Next, holding the neck of the flask with a clamp, put the flask into the steam-bath for a few minutes, take out and quickly connect with the suction pump (a large-sized Chapman is very good). The flask will be rapidly exhausted, and the solution will boil vigorously and all carbon dioxide will be expelled. The evaporation cools the contents of the flask rapidly, and if there is any doubt that all carbon dioxide has been expelled, the heating and boiling may be repeated, as there is no fear of losing boric acid, except mechanically. Note that the solution should be colourless when hot as well as when cold; if not, add more acid and heat again. Sometimes the yellow colour of the nitrophenol is seen in the hot liquid, due to the decomposition of the bicarbonates and showing that not enough acid has been added. The phenolphthalein indicator will often separate out as an insoluble white precipitate as the solution cools. This is of no particular consequence as it clears up again later, and experiments seem to indicate that 1 cc. of this indicator solution is better to use than a smaller quantity. The solution is now cold and free from carbon dioxide. Break the vacuum and run in N/1 sodium hydroxide solution till the last drop turns the nitrophenol indicator yellow. Now run back to acid reaction with one drop of N/1 sulphuric acid, and then run to just alkaline reaction with N/10 sodium hydroxide. In some cases in running to alkaline reaction with N/10 sodium hydroxide solution, the yellow colour is very faint (due to large amounts of salts present, or possibly to carbon dioxide not previously expelled), but usually it is well marked. At any rate run to the first point that you are sure is yellowish. Now take 40 cc. of strong glycerol in the 50 cc. graduated cylinder and pour it into the flask, rotating the latter to mix the contents. About 35 cc. of glycerol will flow out with moderate draining. The titration with N/10 or N/1 sodium hydroxide solution (depending on how large a quantity of boric acid is present, and the titration in methyl alcohol has indicated this) is proceeded with till the last drop gives a decided colour change to a reddish or pinkish shade. It is not necessary to run to a decided pink colour, as one drop of N/10 sodium hydroxide solution in excess makes a decided

* From the *Journal of the American Chemical Society*, xxviii., No. 7.

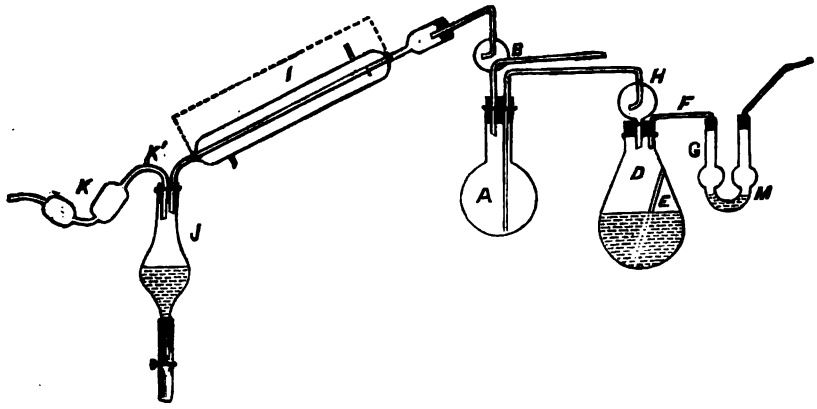


FIG. 1.

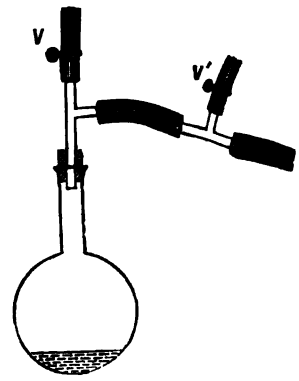


FIG. 2.

A, distillation flask. Capacity about 275 cc. Rests in asbestos cloth on retort stand ring.

B, splash trap, about 5 cm. in diameter. From top of flask to top of bend is about 12 cm.

C, vapour tube. Internal diameter about 4 mm., and at end inside the flask 2½ mm.; this tube must not have too small an opening in the flask on account of danger of becoming clogged.

D, flask made from an 800 cc. Jena glass Kjeldahl digestion flask, cut off as shown. The methyl alcohol is boiled in this flask. It is furnished with the absolutely necessary boiling tube E.

E, boiling tube, about 16 cm. long, with a capillary bore. About 1 cm. from the end in the alcohol it is sealed. Without this tube the alcohol on boiling bumps fearfully, and would endanger the apparatus and operator. With this tube the boiling is easy, uniform, and without danger. It is necessary to shake out the alcohol from the capillary and put it back into the alcohol each time the solution is started boiling.

F, bend and rubber tube connecting the boiling flask with the small safety U-tube.

G, U-tube of small size containing a little mercury in the bend. This acts as a safety-valve in case the apparatus gets clogged, and prevents the blowing out of the stopper from the boiling flask. A long tube leads from the U-tube to carry off the alcohol vapour should it blow out. The rubber tube should slope towards the boiling flask.

H is a splash trap, the same as B, except that the tube leads from it at right angles. It is connected with C by a sliding piece of rubber tubing.

I is the condenser, about 38 cm. long between the dotted lines and about 50 cm. over all.

J is the collecting flask. Mine is made by blowing out the bottom of a 200 cc. Erlenmeyer flask and drawing down to a tube. It is furnished with a rubber tube and pinch-cock at the bottom.

K is the absorption tube with the water seal, to prevent loss of methyl borate. At the end of each 100 cc. of distillate, the contents of this tube are run into the distillate taken off. K' = rubber connection.

Flask connected to vacuum pump VV' (Fig. 2) are T-tubes and rubber tubing with screw pinch-cocks. The vacuum should always be broken by opening cock V to prevent any possible return of condensed water.

change from the strong yellow of the nitrophenol to a colour with a reddish tint due to phenolphthalein. The progress of the titration is well seen in the change of depth of colour due to nitrophenol. As the end-point is approached the yellow colour grows very intense. The difference between the end-point to nitrophenol and phenolphthalein multiplied by 0·0062024 gives the grms. of boric acid, if N/10 alkali has been used in the titration. Each 100 cc. of distillate, or whatever quantity is drawn off each time, is tested in this way. A blank had best be run by taking 10 cc. of N/1 sodium hydroxide solution, adding a slight excess of N/1 sulphuric acid, and about 10 cc. of water, and boiling under vacuum as in the test, and then bringing to just alkaline reaction to nitrophenol with N/10 sodium hydroxide solution, adding the same amount of glycerol and titrating to the end-point with phenolphthalein indicator.

There need be no mistaking the end-points, and test experiments have shown that nitrophenol gives the same end-point as methyl-orange (first noticeable change), and is greatly to be preferred, as there is no change through several shades to the end as there is with methyl-orange. However, methyl-orange may be used with equal accuracy, paying due attention to running to the same shade of end-point each time. An exception must be made to the last statement in regard to the preliminary titration of the boric acid when in methyl alcohol solution. Methyl-orange here is of no value. If for any reason it is found necessary to use more than 10 cc. of water and 5 cc. of hydrochloric acid in the distillation flask, it will be necessary to increase the amount of calcium chloride to take care of the additional water. Use about two-thirds of a grm. of calcium chloride to 1 cc. of the aqueous solution in the distillation flask. The idea is to have all the boric acid in solution, as then it is quickly volatilised. The arrangement of the apparatus will be seen from the sketch.

(To be continued).

Royal Institution.—On Tuesday next, February 12, at 3 o'clock, Professor William Stirling begins a course of six lectures at the Royal Institution on "The Visual Apparatus of Man and Animals"; on Thursday, February 14, at the same hour, Mr. A. Harker gives the first of two lectures on "The Minute Structures of Igneous Rocks and their Significance"; and on Saturday, February 16, also at 3 o'clock, Professor J. J. Thomson commences a course of six lectures on "Röntgen, Cathode, and Positive Rays." The Friday Evening Discourse on February 8 will be delivered by Professor I. Gollancz on "Old English Poetry," and on February 15 by Mr. J. J. Lister on "Foraminifera."

THE

CARRYING DOWN OF AMMONIUM OXALATE BY OXALATES OF THE RARE EARTHS.*

By GREGORY PAUL BAXTER and ROGER CASTLE GRIFFIN.

A RAPID and convenient method for approximate atomic weight determinations of the trivalent metals of the rare earths is the "permanganate" method, in which the ratio $M_2O_3 : 3C_2O_3$ is determined. In this process a known weight of the oxalate of the rare earth is ignited to oxide and the latter is weighed. Then a known weight of the same sample of oxalate is dissolved in sulphuric acid, and the oxalic acid is titrated with standard potassium permanganate.

By dividing the ratio $\frac{M_2O_3}{M_2(C_2O_4)_3}$ found in the first process by the ratio $\frac{3C_2O_3}{M_2(C_2O_4)_3}$ found in the second, the ratio $\frac{M_2O_3}{3C_2O_3}$ is determined, from which the atomic weight may be calculated. (This method was first proposed by Stolba, *Sitzber. Böhm. Ges.*, Dec., 1878; also CHEMICAL NEWS, 1880, xli., 31).

It has already been pointed out by Gibbs (*Proc. Am. Acad.*, 1893, xxviii., 262) and others that the oxalates of the rare earths contain varying amounts of water, and that it is very necessary to grind thoroughly the whole specimen of oxalate which is to be used for analytical purposes, in order to ensure homogeneity of material. Furthermore, the fact has long been recognised that in the presence of potassium or sodium oxalates some of these substances may be carried down by the insoluble oxalates. Large discrepancies in the observed atomic weight as determined by the above method, with material which had been precipitated by oxalic acid or ammonium oxalate, led to the following research upon the effect of varying conditions upon the composition of the oxalates of certain of the rare earths. It is found that ammonium oxalate also, but not oxalic acid, may be carried down in considerable quantities by the rare earth oxalates.

Neodymium was the first element studied. A specimen of oxalate was ignited to oxide, and dissolved in a considerable excess of nitric acid. The absorption spectrum of the solution showed the bands of neodymium only. A portion of the solution was then slowly added, with constant stirring, to a solution of a large excess of oxalic acid. The resulting oxalate was washed ten times by decantation with hot water, and collected on a porcelain Gooch crucible, provided with a disk of filter-paper instead of asbestos. On testing the filtrate the precipitation of the neodymium was found to be complete. After the oxalate had been dried in an electric air-bath at 120—130° for about twenty hours, it was thoroughly mixed by grinding in a porcelain mortar.

Portions of about 0·5 grm. were then transferred from a weighing-bottle to weighed platinum crucibles, and the crucibles were ignited, first in a Bunsen flame, and finally for several minutes with a blast-lamp. The crucibles were allowed to cool in desiccators, and were again weighed. In each case a repetition of the ignition failed to change the weight of the oxide.

Next, portions of from 0·2 to 0·3 of a grm. of the oxalate were weighed into Erlenmeyer flasks, and after the addition of about 5 cc. of concentrated sulphuric acid diluted with 50 of water, the flasks were heated an the steam-bath until the oxalate was completely dissolved. Then the oxalic acid was determined by titration with potassium permanganate solution. This solution was standardised with oxalic acid which had been allowed to come to constancy over sulphuric acid of the sp. gr. 1·35. The oxalic acid had been many times re-crystallised, first from hydrochloric acid solution, then from pure water until free from chlorides.

Since the weight of oxalate found experimentally was considerably less than 100 per cent, as a check on the process the water content was determined by igniting weighed portions of the oxalate in a porcelain boat in a current of dry air, and absorbing the water in a weighed phosphorus pentoxide tube.

The results of the complete analysis are as follows:—

	I.	II.	III.	Average.
Weight of oxalate..	0·6505	0·5938	0·5865	
Weight of Nd_2O_3..	0·3182	0·2908	0·2869	
Per cent of Nd_2O_3 .	48·92	48·97	48·92	48·94
Weight of oxalate..	0·3164	0·3230	0·2613	
Vol. of $KMnO_4$ sol.	28·03	28·60	23·16	

1 cc. $KMnO_4$ = 0·003547 grm. C_2O_3.

C_2O_3 calculated ..	0·0994	0·1014	0·0822	
Per cent of C_2O_3 ..	31·43	31·41	31·44	31·43
Weight of oxalate..	0·6575	0·6264		
Weight of water ..	0·1278	0·1241		
Per cent of water..	19·44	19·81		19·62
			Total..	99·99

$$\text{Ratio, } M_2O_3 : 3C_2O_3 = \frac{48·94}{31·43} = 1·5571$$

$$M = 144·2 \quad (Nd = 143·6)$$

The observed value for the atomic weight of neodymium is as near the most probable value of this constant as the purity of the sample would lead one to expect. Since the oxalate used in the above experiments was precipitated with a very large excess of oxalic acid, the possibility existed that some of the precipitant had been carried down by the precipitate. In order to determine whether this was the case, another sample of the same material was precipitated in a similar manner, but with a very slight excess of oxalic acid.

	I.	II.	III.	Average.
Per cent of Nd_2O_3..	58·02	57·98	57·94	57·98
Per cent of C_2O_3 ..	37·25	37·27	37·17	37·23

$$\text{Ratio, } M_2O_3 : 3C_2O_3 = \frac{57·98}{37·23} = 1·5573$$

$$M = 144·2 \quad (Nd = 143·6).$$

The agreement of the values for the atomic weight of neodymium obtained from the analyses of oxalate which had been precipitated with a very large and with a slight excess of oxalic acid shows conclusively that no appreciable tendency for the carrying down of oxalic acid exists.

Precipitation by means of ammonium oxalate was next investigated. A solution of neodymium oxide in nitric acid was nearly neutralised with ammonia, and was added to a slightly ammoniacal solution of a small excess of ammonium oxalate. Precipitation was found to be complete. After the precipitation the supernatant liquid was faintly acid. By adding the neodymium solution to the oxalate, occlusion, if it exists at all, is to be expected to be at a maximum. The oxalate was thoroughly washed, dried, and powdered. Then it was analysed as before.

	I.	II.	III.	Average.
Per cent of Nd_2O_3..	50·65	50·58	50·70	50·64
Per cent of C_2O_3 ..	37·99	38·01	38·02	38·01
Per cent of H_2O ..	11·28	11·22		11·25
			Total..	99·90

$$\text{Ratio, } M_2O_3 : 3C_2O_3 = \frac{50·64}{38·01} = 1·3322$$

$$M = 119·9 \quad (Nd = 143·6)$$

Since it was certain from these results that the salt contained too much oxalate, and since it was probable that the excess was due to ammonium oxalate which had been carried down by the neodymium oxalate, a portion of the precipitate was tested for ammonia, after solution in nitric acid, by adding an excess of potassium hydroxide. Ammonia was evolved in quantity, It was evident, therefore, that ammonium oxalate is carried down by neodymium

* From the *Journal of the American Chemical Society*, xxviii., No. 12.

oxalate to a considerable extent. The determination of the water in this oxalate includes the ammonia as well as the water. However, since ammonium oxalate, when heated breaks up partially into cyanogen and water, this determination is slightly in error. During the analysis of the oxalate for water the odour of cyanogen was perceptible.

(To be continued).

DEATH OF PROFESSOR MENDELEEFF.

Dmitri Ivanovitch Mendeleeff, the greatest chemist whom Russia has produced, died at St. Petersburg on February 2nd, within less than a week of reaching his seventy-third birthday.

He was born at Tobolsk, in Siberia, and was educated at the local gymnasium, of which his father was director; his strong bent for natural science early showing itself, he continued his studies at the University of St. Petersburg, where he obtained the M.A. degree, for which he prepared a dissertation on specific volumes and problems concerning the specific gravities and volumes, and the chemical composition of substances.

In 1861 he published accounts of his investigations of the absolute boiling-points of gases, and his fundamental experiments were afterwards amplified and further explained by Andrews, who called the absolute boiling-point the critical temperature. After graduation Mendeleeff adopted teaching as a profession, and from 1860 to 1863 he resided at Heidelberg, where he directed a private laboratory, afterwards returning to St. Petersburg, first as Professor of Chemistry at the Technological Institute, to become, after three years, Professor at the University, which post he held until 1900, when he was appointed Head of the Standards Department. Soon after he obtained the University Professorship he began to write his "Principles of Chemistry," of which seven editions have appeared in Russian and three in English, while it was translated also into German. The object of this text-book was to "acquaint the student not only with the experimental facts and laws of chemistry, but also with the insight given by this science into the unchangeable substratum underlying the varying forms of matter," and its peculiar value was speedily recognised. The stamp of the author's strong personality is impressed upon every page, and it is undoubtedly one of the most original of text-books, which chains the reader's attention by the vividness of its style and the free use of imagery, which is a distinguishing feature of the philosophical parts of the text. In the later editions Mendeleeff declared himself an opponent of the theory of electrolytic dissociation, which he thought adds nothing to our comprehension of solutions in general, and which he declared does not accord with the observed facts, and he considered also the notion of splitting atoms up into electrons, so far from simplifying our ideas merely complicates them, while he regarded the theory of the transmutation of one element into another as an incorrect deduction due to vague ideas about the nature of the ether, which he could not accept until it had been definitely demonstrated that one element could actually be transformed into another, or matter into ether.

Valuable as the book was, however, as an authoritative text-book of inorganic chemistry, it was most widely known as the work in which was discussed for the first time in detail Mendeleeff's conception of the Periodic Law. Arguing upon the basis that the two signs or manifestations of matter are (1) mass and (2) individuality, and that both matter and the chemical elements are indestructible, he deduced that there must be some bond of union between mass and the chemical elements, and hence also between the properties of an element and its atomic weight. This conception led him to compare the atomic weights and typical properties of the elements, and the result was a paper read before the Russian Chemical Society in March, 1869, entitled "On the Correlation of the Properties and Atomic Weights of the Elements." This paper included practically all the points of the Periodic Law as now generally accepted, and in subsequent articles only further applications of the same principles are to be found.

In his text-book Mendeleeff stated that although when arranging the periodic system he made use of the previous researches of Dumas, Gladstone, and Pettenkofer on the atomic weights of allied elements, he was unacquainted with the work of De Chancourtois and of Newlands, the latter of whom five years previously had called attention to the periodicity of the properties of the elements when arranged in the order of their atomic weights, and had suggested that the unoccupied spaces in the table might be filled by elements then undiscovered, or by known elements whose atomic weights had not been accurately determined. Newlands' work, however, had been received with incredulity and even derision, and it was reserved to Mendeleeff to arouse the genuine interest of the scientific world. This was more particularly due to the fact that he had such a profound belief in the universality of the principle he had enunciated that he did not hesitate to prognosticate from it, and even to correct accepted atomic weights. Thus he foretold not only the existence, but also the general properties and chemical behaviour of new and then undiscovered elements, to fill up blanks in the table he had constructed, and when gallium, scandium, and germanium were isolated it was found that they fulfilled these predictions in a most striking manner, while the existence of the inert gases of the atmosphere had also been foretold from the Law. Moreover, the researches of Roscoe and Zimmermann have shown that he was correct in altering the atomic weight of uranium from 120, which was generally accepted in 1869, to 240, and thus making it correspond with the Periodic System.

It is pleasing to notice that with genuine nobility of mind Mendeleeff recognised that Newlands, De Chancourtois, and Strecker had all independently arrived at the same result, and in the Faraday Lecture delivered by him before the Fellows of the Chemical Society in June, 1889, he said that "they merely wanted the boldness necessary to place the whole question at such a height that its reflection on the facts could be clearly seen," and it is for his intrepidity and the courage of his convictions that he is to be admired, no less than for his remarkable perspicuity.

It was not to be expected that a man of such imagination and daring would, as long as life and strength lasted, cease from putting before the world speculations the truth of which time and research alone could test, and to the present generation he has left as a legacy a hypothesis which is of the most absorbing interest. This is contained in an essay, published in 1902, "An Attempt towards a Chemical Conception of the Ether." Starting with the assumption that the ether possesses both mass and materiality, and by extrapolation inserting a zero group in the Periodic System, and a zero series of elements lighter than hydrogen, he deduced that in this series one element should have an atomic weight many times less than that of hydrogen, *i.e.*, less than 10^{-6} if H = 1; it should have a monatomic molecule like argon and helium, and its exceedingly small density, or, in other words, the exceedingly rapid motion of its molecules, should enable it to permeate and penetrate all matter and space. This gaseous element he believed to be the ether, and he was satisfied that the recently discovered physico-chemical phenomena connected with radio-activity could be satisfactorily explained by assuming the emission of a portion of this ether and the entrance of new ether into the sphere of attraction of particles of normal mean velocity, if it were supposed that uranium and thorium, having the highest atomic weights among the elements, would have in the highest degree that power of attraction which lies between gravity and chemical affinity, and which would cause the accumulation of ether atoms round their molecules. This daring conception of the ether was practically the last product of the brain of the great chemist, and as such is now invested with a pecular interest for those who are left to lament his loss.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, January 17th, 1907.

Prof. R. MELDOLA, F.R.S., President, in the Chair.

MESSRS. P. S. Arup, W. C. Ball, and J. Hamer were formally admitted Fellows of the Society.

The PRESIDENT announced the decision of the Council that during the remainder of the present Session the Library shall be kept open for the use of Fellows every Thursday from 10 a.m. until 9 p.m., except on those evenings on which the Society meets, when it will remain open until 10.30 p.m.

Certificates were read for the first time in favour of Messrs. Leslie Hamilton Berry, B.Sc., Penshurst, Croham Park Avenue, S. Croydon; Mohan Nath Kedarnath Dikshit, 21, Burlington Road, Bayswater, W.; John Edwin Farmer, Blelsoe, New Road, Mitcham Junction; Percival John Fryer, 27, Minster Road, Cricklewood, N.W.; William Heber Green, D.Sc., The University, Melbourne; Richard Higham, 133, Mauldeth Road, Withington, Manchester; William James Hoyten, M.R.C.S., F.R.C.P., 37, Ravelstoke Road, Wimbledon Park, S.W.; Francis Townshend Cunynhame Hughes, Major, Royal Mint, Calcutta, India; Sidney James Jennings, B.Sc., 367, Queen's Road, New Cross, S.E.; George Lunan, 50, Garscube Terrace, Murrayfield, Edinburgh; William George Twiney, B.Sc., St. Joseph's College, Colombo, Ceylon; Charles Rowlatt Watkins, B.A., Aldenham School, Elstree, Herts; William Henry Williams, Government Education Dept., Hong Kong.

The Council has ordered the following letter and report to be printed in the *Journal* and *Proceedings* of the Society:—

Government Laboratory,
Clement's Inn Passage, Strand, London, W.C.,
15th November, 1906.

GENTLEMEN,—I have the honour to forward to you, for presentation to the Council of the Chemical Society, the Report of the International Committee on Atomic Weights, 1907, to which I have affixed, as desired by them, the names of Professors Moissan and Ostwald.

The Committee, for reasons stated in the Report, have suggested new values for the atomic weights of bismuth, nitrogen, tantalum, and terbium, and they are further of opinion that alterations are needed in the atomic weights of silver and chlorine, but before recommending any change as regards these elements they consider it expedient to wait for fuller information of the results of determinations known to be in progress. The new values for silver and chlorine will, of course, have an influence upon a large number of atomic weights.—I am, Gentlemen, Your obedient Servant, T. E. THORPE.

The Hon. Secretaries, The Chemical Society,
Burlington House, London, W.

Report of the International Committee on Atomic Weights, 1907.

Since the preparation of our last report, for 1906, a number of important memoirs upon atomic weights have appeared. The results obtained may be briefly summarised as follows:—

Bismuth.—Work done at Erlangen under the direction of Gutbier (*Zeit. Elektrochem.*, 1905, xi., 831) has been published in the form of three doctoral dissertations (L. Birckenbach, 1905; H. Mehler, 1905; R. L. Janssen, 1906). Birckenbach, by synthesis of the oxide from the metal, found, in mean, Bi = 208·05. A series of reductions of the oxide gave Bi = 208·08. Mehler determined the ratio $BiBr_3 : AgBr$, and found Bi = 208·05. By synthesis of the sulphate from the metal, Janssen obtained the value Bi = 208·074. These determinations are concordant, and also agree with the earlier measurements by Schneider and Löwe, and with a series by Marignac. The atomic weight of bismuth, therefore, is to be taken as 208·0 in round numbers, and the value 208·5, as hitherto given in our table, is too high.

Bromine.—Baxter's (*Journ. Am. Chem. Soc.*, 1906, xxviii., 1322) determinations of this constant are based upon the antecedent values Ag = 107·93 and Cl = 35·473. Eighteen syntheses of silver bromide gave, in mean, Br = 79·953. Thirteen experiments upon the conversion of AgBr into AgCl gave Br = 79·952.

Cadmium.—The memoir by Baxter, Hines, and Frevert (*Ibid.*, 1906, xxviii., 770) is a continuation of the research which was noted last year. Four ratios were measured with the following results, when Ag = 107·93:—

$CdBr_2 : Ag$	Cd = 112·470
$CdBr_2 : 2AgBr$	Cd = 112·464
$CdCl_2 : 2Ag$	Cd = 112·471
$CdCl_2 : 2AgCl$	Cd = 112·470

Copper.—A series of analyses and syntheses of copper oxide by Murmann (*Monatsh.*, 1906, xxvii., 351) gave the value Cu = 63·53. The data are not concordant, and the determinations are not entitled to much weight.

Iodine.—Gallo (*Gazetta*, 1906, xxxvi., 116) has determined the atomic weight of iodine electrolytically, comparing the iodine liberated by a current with the silver deposited. His values range from 126·82 to 126·98, or, in mean, 126·89 when Ag = 107·93. This result is more nearly in accord with the determination by Stas than with the later measurements.

Nitrogen.—Gray's (*Trans.*, 1905, lxxxvii., 1601) work upon the atomic weight of this element, noticed in our report for 1906, has since been published in full. His mean results are as follows:—From the density of nitric oxide, N = 14·006; from the analysis of nitric oxide N = 14·010; from the density of nitrogen, N = 14·008. The mean of all the determinations is N = 14·0085, or very nearly 14·01. This agrees closely with the earlier measurements by Guye, Rayleigh, and Leduc, and leaves no reasonable doubt but that the new value should replace the 14·04 as given in our annual table. In a later paper (*Trans.*, 1906, lxxxix., 1173) Gray has gathered corroborative evidence from various sources, and has discussed Stas's ratios in order to discover their possible errors. Other discussions of similar purport are by Guye (*Ber.*, 1906, xxxix., 1470; for Guye and Bogdan's complete memoir upon nitrous oxide, see *Journ. Chim. Phys.*, 1905, iii., 537) and Scott (CHEMICAL NEWS, 1906, xciii., 20), but they are not final. Experimental evidence alone can reveal the cause of discrepancy between the new figure and the old.

Palladium.—Amberg (*Annalen*, 1905, cccxli., 235) has re-determined the atomic weight of palladium by analysis of palladosoammine chloride, $PdN_2H_6Cl_2$. The value obtained is Pd = 106·688, or 106·7 nearly. Five other analyses of the same salt, by Krell (*Inaug. Dissertation*, Erlangen, 1906), gave a mean of Pd = 106·694. Recalculated with Richards's value for Cl, and rejecting on experiment as defective, Krell concludes that Pd = 106·78 but this again would be lowered by the adoption of the newer value for N. Any change in this constant may well be deferred until the antecedent atomic weights are more definitely known.

Silver.—In an attempt to determine the source of error in Stas's figures for nitrogen, Guye and Ter Gazarian examined the fundamental potassium chlorate ratio (*Comptes Rendus*, 1906, cxliii., 411; see also *Journ. Chim. Phys.*, 1906, iv., 174, for a paper by Guye on the need of a general re-calculation of atomic weights). They found that potassium chlorate crystallises with a small quantity of chloride as an impurity, the amount being nearly constant, and about 2·7 parts in ten thousand. Applying this correction to Stas's ratios, his value for silver is lowered from 107·93 to 107·89. A re-discussion of ten fundamental ratios gave figures for silver ranging from 107·871 to 107·908, or 107·89 in mean. If this conclusion is sus-

tained, the Stas's ratios for silver nitrate will give a value for nitrogen in harmony with the figures obtained by Guye and Gray.

Tantalum.—Hinrichsen and Sahlbom (*Ber.*, 1906, xxxix., 2600) have determined the atomic weight of tantalum by conversion of the metal into the pentoxide. Five such syntheses gave Ta = 180·59 to 181·77, or 181·0 in mean. This value should replace the old determination by Marignac as given in our previous tables.

The Rare Earths.—On the metals of this group a notable amount of work has been published during 1906. From five determinations of water in terbium sulphate, Urbain (*Comptes Rendus*, 1906, cxlii., 957) deduces the value Tb = 159·22; and this should supplant the older, questionable data. In another paper (*Ibid.*, 1906, cxliii., 785) Urbain gives an atomic weight of 163·49 to dysprosium, but without details or weighings.

By a volumetric method, Feit and Przibylla (*Zeit. Anorg. Chem.*, 1906, l., 249) have determined the amount of sulphuric acid required to neutralise several of the oxides in this group, and have in that way obtained new estimates of the corresponding atomic weights. The final results, reduced to a vacuum standard, are as follows:—

Lanthanum	139·17
Praseodymium	140·62
Neodymium	144·52
Samarium	150·47
Europium	152·66
Gadolinium	157·38
Ytterbium	173·52
Yttrium	89·40

In Abegg's "Handbuch der Anorganische Chemie," Brauner has given full summaries of all atomic weight determinations. With these summaries, in connection with the rare earth metals (in Bd. iii., Abth. 1, pp. 263, 276, 284, 304, 318, 335), he has cited some hitherto unpublished determinations of his own. His results are:—

Praseodymium	140·97
Neodymium	143·89
Samarium	150·71
Gadolinium	155·78
Erbium	167·14
Ytterbium	173·08

Among these figures that for Gd is admittedly too low, and that for Sa is vitiated by the presence of europium in the material studied.

From the evidence presented in this Report, and in preceding years, we now feel justified in recommending the following changes in the table:—

Nitrogen,	from	14·04	to 14·01.
Bismuth,	„	208·5	„ 208·0.
Tantalum,	„	183·0	„ 181·0.
Terbium,	„	160·0	„ 159·2.

Other changes which seem to be needed because of alterations in the atomic weights of silver and chlorine cannot yet be made with safety. The atomic weight of silver, as deduced from Stas's data, is probably too high, but by an unknown amount, and that will affect the entire table. If we assume, with Guye, that Ag = 107·89, with the proportional changes in Cl and Br, the atomic weight of barium, as determined by Richards, will be reduced by 0·05. Such a change, which is probably extreme, does not affect the utility of the accepted atomic weights at all seriously, and no important interest will suffer if we delay the suggested alterations until our knowledge of the corrections to be applied is more exact. Guye's conclusions, although strongly supported, are not final, and they should be neither accepted nor rejected except upon the basis of much more complete evidence than we now possess. The atomic weight of chlorine, as given in our last Report, is certainly too low, but it depends in part upon the undetermined change to be applied to silver. For that reason as well as for the reason that a change in chlorine affects many other values, we prefer to leave the figures as they are and to wait for fuller information. That information will doubtless be supplied by researches now known to be in progress, and the corrections which they will furnish ought not to be delayed very long.

One addition to the table seems to be legitimate. Europium, with an approximate atomic weight of 152, appears to be a definite element, as shown by the investigations of Demarçay, Urbain and Lacombe, Eberhard, and Feit and Przibylla. Its existence is recognised in Abegg's "Handbuch," and its claims to a place in the table are certainly as great as those of erbium, thulium, or terbium. As for dysprosium, its admission to the table may well be delayed until a better determination of its atomic weight shall have been made.

In conclusion, we urge upon all chemists who are engaged in the determination of atomic weights to send copies of their publications to all the members of this Committee in order that their work may be promptly recognised and not overlooked. Data published in standard journals are of course easily found, but publications of local societies and doctoral dissertations might readily escape our notice.

Professor Seubert, an original member of this Committee has resigned. Professor Ostwald has been designated as his successor. (See *Ber.*, 1906, xxxix., 2176 for the formal announcement of this change).

The Table offered for 1907 is appended hereto.

F. W. CLARKE,
HENRI MOISSAN,
WILHELM OSTWALD,
T. E. THORPE.

International Atomic Weights. (1907).

Aluminium	Al	27·1
Antimony	Sb	120·2
Argon	A	39·9
Arsenic	As	75·0
Barium	Ba	137·4
Bismuth	Bi	208·0
Boron	B	11·0
Bromine	Br	79·96
Cadmium	Cd	112·4
Cæsium	Cs	132·9
Calcium	Ca	40·1
Carbon	C	12·00
Cerium	Ce	140·25
Chlorine	Cl	35·45
Chromium	Cr	52·1
Cobalt	Co	59·0
Columbium	Cb	94
Copper	Cu	63·6
Erbium	Er	166
Europium	Eu	152
Fluorine	F	19·0
Gadolinium	Gd	156
Gallium	Ga	70
Germanium	Ge	72·5
Glucinum	Gl	9·1
Gold	Au	197·2
Helium	He	4·0
Hydrogen	H	1·008
Indium	In	115
Iodine	I	126·97
Iridium	Ir	193·0
Iron	Fe	55·9
Krypton	Kr	81·8
Lanthanum	La	138·9
Lead	Pb	206·9
Lithium	Li	7·03
Magnesium	Mg	24·36
Manganese	Mn	55·0
Mercury	Hg	200·0
Molybdenum	Mo	96·0
Neodymium	Nd	143·6
Neon	Ne	20

Nickel	Ni	58·7
Nitrogen	N	14·01
Osmium	Os	191
Oxygen	O	16·00
Palladium	Pd	106·5
Phosphorus	P	31·0
Platinum	Pt	194·8
Potassium	K	39·15
Praseodymium	Pr	140·5
Radium	Rd	225
Rhodium	Rh	103·0
Rubidium	Rb	85·5
Ruthenium	Ru	101·7
Samarium	Sa	150·3
Scandium	Sc	44·1
Selenium	Se	79·2
Silicon	Si	28·4
Silver	Ag	107·93
Sodium	Na	23·05
Strontium	Sr	87·6
Sulphur	S	32·06
Tantalum	Ta	181
Tellurium	Te	127·6
Terbium	Tb	159·2
Thallium	Tl	204·1
Thorium	Th	232·5
Thulium	Tm	171
Tin	Sn	119·0
Titanium	Ti	48·1
Tungsten	W	184
Uranium	U	238·5
Vanadium	V	51·2
Xenon	Xe	128
Ytterbium	Yb	173·0
Yttrium	Yt	89·0
Zinc	Zn	65·4
Zirconium	Zr	90·6

Of the following papers those marked * were read :—

*1. "*The Relation between Absorption Spectra and Optical Rotatory Power.* Part I. *The Effect of Unsaturation and Stereoisomerism.*" By ALFRED WALTER STEWART.

The author has examined the absorption spectra of certain saturated and unsaturated acids, and compared the results with the rotatory power of their amyl esters. The results show that a close relation exists between the general absorption power of compounds and their molecular rotation. The substance having the greater general absorption has also the greater molecular rotation. The case of the amyl esters of hydrocinnamic, cinnamic, and phenylpropiolic acids, which seems anomalous at first sight, agrees with this. An examination of the spectra of some stereoisomeric acids of the ethylene series showed that the rule holds in their case also. Experiments are in progress in other branches of the subject, for example, active and inactive isomerides, birotation, the influence of the solvent on the rotatory power, &c.

DISCUSSION.

Dr. MCKENZIE pointed out that the values for the molecular rotations of the amyl esters of hydrocinnamic, cinnamic, and phenylpropiolic acid respectively, determined by Walden and quoted by the author, were obviously incorrect, since the amyl alcohol used by Walden in 1896 was a mixture.

Since it was now possible to separate the optically active constituent of fusel oil in a pure state by means of 3-nitrophthalic acid (*Ber.*, 1901, xxxiv., 485), he asked whether the author had prepared the pure esters in question and determined their rotations.

Mr. STEWART explained that owing to the complexity of the amyl spectrum it had been found best to examine the spectra of the acids and not those of the amyl esters. The cause of the change in rotation evidently is to be sought in the acidic part of the ester molecule. The results obtained by Sir W. H. Perkin in the case of the magnetic rotation of saturated and unsaturated acids agree with those observed in the case of optically active esters of the saturated and unsaturated series.

*2. "*Organic Derivatives of Silicon.* Part II. *The Synthesis of* dl-*Benzylethylpropylsilicol, its Sulphonation, and the Resolution of the Sulphonic Derivative into Optically Active Components.*" By FREDERIC STANLEY KIPPING.

dl-*Benzylethylpropylsilicol*, EtPrBzSi·OH, has been synthesised by the following series of reactions (compare *Proc.*, 1904, xx., 15):—

$$SiCl_4 + MgEtBr = SiEtCl_3 + MgClBr.$$
$$SiEtCl_3 + MgPhBr = SiEtPhCl_2 + MgClBr.$$
$$SiEtPhCl_2 + MgPrBr = SiEtPhPrCl + MgClBr.$$
$$SiEtPhPrCl + MgBzCl = SiEtPhPrBz + MgCl_2.$$
$$SiEtPhPrBz + H_2O(+H_2SO_4) = = SiEtPrBz\cdot OH + C_6H_6(+H_2SO_4)$$

The silicol thus initially produced yields, with sulphuric acid, a mixture of sulphonic acids, of which one has been isolated in the form of its ammonium salt.

This acid is probably a derivative of the corresponding oxide, having the constitution—

$$SO_3H\cdot C_6H_4\cdot CH_2\cdot SiEtPr\cdot O\cdot PrEtSi\cdot CH_2\cdot C_6H_4\cdot SO_3H;$$

it is the externally compensated compound, and although many of its salts with optically active bases crystallise unchanged, the *d*-methylhydrindamine salt can be resolved by crystallising fractionally from aqueous methyl alcohol.

The *d*B*d*A-salt is the more sparingly soluble and melts at about 205°; the impure *d*B*l*A-salt from the most soluble fractions melts at about 135°.

The *l*B*l*A-salt has been prepared by resolving the acid with *l*-methylhydrindamine.

The two optically active acids have very low specific rotations ($[\alpha]_D \pm 4°$ roughly), but there is ample evidence of their enantiomorphous relationship.

DISCUSSION.

Dr. LEWKOWITSCH, referring to the statement that different melting-points were obtained with one and the same substance, asked whether this phenomenon was accompanied by the appearance of different colours, such as Jaeger had observed in the case of the liquid anisotropic phases of the esters of cholesterol and phytosterol at their different melting-points.

Prof. KIPPING stated that the appearance of such colours had not been observed by him.

*3. "*The Association of Phenols in the Liquid Condition.*" By JOHN THEODORE HEWITT and THOMAS FIELD WINMILL.

The authors have determined the surface energy of several liquids, and find that the association of phenols is diminished or entirely inhibited by the presence of ortho-substituents. Comparison with meta- and para-isomerides has clearly shown that the effect is due more to the position than to the nature of the substituent group.

The effect of steric hindrance is also seen with the aromatic alcohols. Monophenylcarbinol (benzyl alcohol) is markedly associated at the ordinary temperature; the molecular weights of fused di- and tri-phenylcarbinol are, however, normal.

DISCUSSION.

Dr. HEWITT, replying to the remarks of the President, said he supposed that probably they (the authors) had not encountered the best conditions for converting *o*-aminophenol into *o*-bromophenol. Respecting Mr. Baly's contention that any hindrance to association was structural rather than sterical, it was at least remarkable that the groups of larger molecular volume had a more marked effect than those, such as methyl and chlorine, whose molecular volume was smaller.

*4. "*A New Mercuric Oxychloride.*" By JOHN THEODORE HEWITT.

On allowing solutions of sodium hydroxide and mercuric chloride in sodium chloride to diffuse into one another, a layer of sodium chloride solution of intermediate density being interposed, very dark red crystals having the formula $Hg_6O_5Cl_2$ are deposited. These were at first considered to be red mercuric oxide or mercuric hydroxide, since on solution in hot dilute nitric acid and addition of silver nitrate solution no precipitate was obtained.

It has now been found that if a silver chloride precipitate is suspended in dilute nitric acid and mercuric oxide added, not only is the latter dissolved, but also the silver chloride.

In the estimation of chlorine in the oxychloride the latter was dissolved in warm dilute sulphuric acid, the mercury precipitated with sodium hyposulphite, and after oxidation of the excess of this reagent with dilute nitric acid, the chlorine was estimated in the usual way as silver chloride.

DISCUSSION.

Dr. HEWITT was afraid he had not made the fact quite clear, that when silver chloride is dissolved in dilute nitric acid by addition of mercuric oxide the result is not to be attributed to the formation of a complex silver ion, but to the employment of the chlorine in forming complex ions with the mercury. The solubility of silver salts in albumenoid solutions mentioned by Dr. Divers was hardly of a similar nature, in the latter case solution depended rather on colloidal suspension.

*5. "*Preparation of Chromyl Dichloride.*" By HERBERT DRAKE LAW and FREDERICK MOLLWO PERKIN.

The authors find that the best method for preparing chromyl dichloride is to dissolve chromic acid in rather more than the equivalent quantity of concentrated aqueous hydrochloric acid, and to add to this solution concentrated sulphuric acid in small quantities at a time, the mixture being cooled between each addition. After standing for about twenty minutes in a tap funnel the heavy under layer of chromyl dichloride is drawn off. It can be purified by aspirating dry air through it and subsequent distillation. The yield is almost theoretical.

*6. "*Oxidation of Hydrocarbons of the Benzene Series.*" By HERBERT DRAKE LAW and FREDERICK MOLLWO PERKIN.

The authors have examined the products of oxidation of aromatic hydrocarbons by lead peroxide and manganese peroxide in acid solution, by chromyl dichloride, and by persulphates in acid solution in presence of silver salts.

The hydrocarbons investigated were toluene, the three xylenes, mesitylene, ψ-cumene, and cymene. In all cases varying yields of the monoaldehydes were obtained.

Toluene gave with lead peroxide 24 per cent of benzaldehyde, with manganese peroxide 5 per cent, with chromyl dichloride 44 per cent, and with persulphates 78 per cent. In the remaining cases, as a rule, the yield with chromyl dichloride was better than with the other oxidising agents, that obtained with persulphates being second. In general, lead peroxide gave a larger quantity of aldehyde than did manganese peroxide.

7. "*The Constitution of Silver Nitrate; a Correction.*" By EDWARD DIVERS.

In the opening paragraph of a paper which has just appeared (*Trans.*, 1906, lxxxix, 1900), Rây and Neogi state that the present writer is inclined to accept as fairly conclusive the evidence which they have adduced in favour of the oxylic constitution of silver nitrite.

In his note in the *Proceedings* (1905, xxi., 281), to which they make reference, no opinion at all is expressed as to the constitution of silver nitrite. The authors must have made the statement under some misapprehension of the writer's words, which he cannot account for.

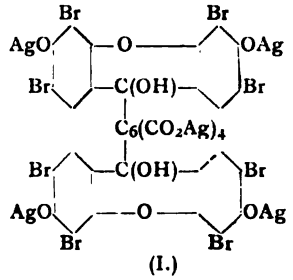
8. "*Aromatic Selenonium Bases.*" By SAMUEL SMILES and THOMAS PERCY HILDITCH.

When anisole or phenetole are heated on the water-bath with selenium dioxide and aluminium chloride, the chlorides of the corresponding selenonium bases are formed. To isolate these substances, the reaction mixture is decomposed with water and freed from excess of phenolic ether by distillation in steam; finally the mixture is extracted with chloroform, which, on evaporation, leaves the chloride of the base as a red oil. *Trianisyl-* and *triphenetylselenonium chlorides* are viscous oils, the aqueous solutions of which yield strongly basic *hydroxides* on treatment with silver oxide. The *iodides* are sparingly soluble oils. The *platinichlorides* were obtained as brown precipitates, insoluble in water and very soluble in acetone. The *platinichloride* of *triphenetylselenonium* melts at 82—83°. The dichromates of these bases are insoluble in water, and are precipitated in yellowish-brown flakes when an acid solution of potassium chromate is added to solutions of the chlorides. They are very unstable, and turn dark on exposure to the air. *Trianisylselenonium dichromate* melts at 65—70°.

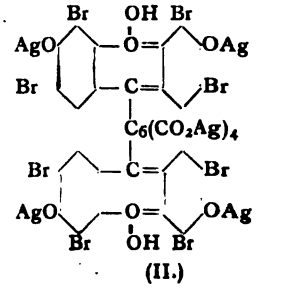
9. "*The Relation of Colour and Fluorescence to Constitution.*" By ARTHUR GEORGE GREEN.

In a paper bearing the above title (*Trans.*, 1906, lxxxvii., 1787), O. Silberrad has recently described a number of complex phthaleins formed by the condensation of mellitic and pyromellitic acids with resorcinol. From the fact that the silver salts of these phthaleins correspond to the substitution of hydrogen by silver, not only in all the carboxyl groups of the mellitic residue, but also in the two phenolic hydroxyl groups of each xanthene ring, it is concluded that "neither the colour nor the fluorescence of these compounds is dependent on the presence of quinone linkings, for in many cases a quinonoid structure is impossible." This conclusion Silberrad is inclined to extend to the phthaleins in general.

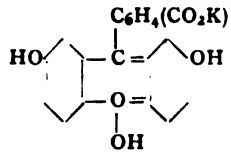
A study of the phthaleins of phenol and quinol, which the author has had in progress for some time past, has brought to light several facts pointing to an opposite conclusion, and strongly confirming the view that the coloured salts of these phthaleins have a quinonoid structure. It therefore appears advisable to point out that Silberrad's deductions are in no sense necessary, but that on the contrary his compounds may be represented with equal or greater probability upon a quinonoid type. For instance, in place of the carbinol formula (I.) for the silver salt of the octabromohexahydroxy-*p*-dixanthylbenzenetetracarboxylic acid, the orthoquinone formula (II.) may be substituted. The latter is analogous to (III.), the formula proposed by the author for the potassium salt of quinophthalein (*Ber.*, 1906, xxxix., 2365):—



(I.)



(II.)



(III.)

10. "*Tetraketopiperazine.*" By ALFRED THEOPHILUS DE MOUILPIED and ALEXANDER RULE.

The authors have studied the action of sodium alkyloxides on esters of the type of ethyl oxamate, $NH_2{\cdot}CO{\cdot}CO_2Et$, whereby the elimination of 1 molecule of alcohol would be expected to give rise to ring compounds containing an imino-group. Ethyl oxamate should by such a reaction furnish oxalimide, $\begin{matrix}CO\\|\\CO\end{matrix}\!\!>\!NH$, which is referred to by Ost and Mente (*Ber.*, 1886, xix., 3228), but its existence appears to be very doubtful. The authors were not able to obtain it, but prepared from ethyl oxamate, *tetraketopiperazine*, which has twice the molecular weight of oxalimide, and which seems to be the substance described under the latter name.

Tetraketopiperazine was also obtained by the condensation of ethyl oxalate with oxamide; a *hydrazone*, *silver*, and *sodium* salts have been prepared, and the following constitutional formula is suggested:—

$$N\!=\!\begin{matrix}C(OH){\cdot}CO\\|\\CO\!-\!\!-\!\!CO\end{matrix}\!\!>\!NH.$$

Methyl succinamate yields succinimide by a similar reaction, and ethyl malonamate gives a *substance* of formula $C_6H_8O_5N_2$, resulting from the condensation of 2 molecules of malonamic acid through loss of 1 molecule of water.

A general method for the preferential saponification of a carboxyalkyl group occurring in the same compound with an acid amide group was described.

Saponified with alkali in the usual way, ethyl oxamate yields the semi-ethyl ester and oxalic acid, and ammonia is simultaneously evolved. By using the theoretical amount of pure sodium alkyloxide in dry benzene solution a large yield of sodium oxamate is obtained.

11. "*Transformations of Highly Substituted Nitroaminobenzenes.* II. *s-Tribromo-1-nitroaminobenzene.*" By ALICE EMILY SMITH and KENNEDY JOSEPH PREVITÉ ORTON.

Treatment of 2 : 4 : 6 - tribromo - 1 - nitroaminobenzene, $C_6H_2Br_3{\cdot}NH{\cdot}NO_2$, with sulphuric acid or a mixture of sulphuric and acetic acids leads to the replacement of a bromine atom by the nitro-group, and to the formation of 2 : 6-dibromo-4-nitroaniline (*Trans.*, 1902, lxxxi., 806). Within very narrow limits of temperature and concentration of the sulphuric acid, the nitroamine is partly converted into bromophenyliminobenzoquinones, analogous to the hexachlorophenyliminobenzoquinone obtained from *s*-trichloronitroaminobenzene (*Trans.*, 1905, lxxxvii., 389). In the case of the bromo-compounds, however, a mixture of two phenyliminobenzoquinones is always formed, namely, a penta- and a hexa-bromo-derivative, $C_6H_2Br_3{\cdot}N : C_6H_2Br_2 : O$ and $C_6H_2Br_3{\cdot}N : C_6HBr_3 : O$; bromine is accordingly set free in the reaction.

s-Tribromophenyliminodibromobenzoquinone crystallises in dark red prisms or needles with a metallic lustre, and melts at 171°. On reduction it yields *s-tribromophenyldibromo-4-hydroxyphenylamine*, which crystallises in white, silky needles melting at 155—156°, and is freely soluble in alcohol and other solvents. The latter can thus be separated from the *s-tribromophenyltribromo-4-hydroxyphenylamine*, which crystallises in colourless needles or prisms melting at 206°. On oxidation it is converted into *s-tribromophenyliminotribromobenzoquinone*, which crystallises in pale red needles or prisms melting at 134—135°, and is more soluble than the pentabromo-derivative in all the usual solvents.

12. "*Resolution of Tetrahydro-p-toluquinaldine into its Optically Active Components.*" By THOMAS CONSTANTINE BECK and WILLIAM JACKSON POPE.

The *d-αβ*-bromocamphorsulphonic acid of Armstrong and Lowry was shown to be applicable for the resolution of externally compensated bases, in accordance with the method of Pope and Peachey, by using it for the separation of the optically active tetrahydro-*p*-toluquinaldines from the corresponding externally compensated mixture. By treating two equivalents of *dl*-tetrahydro-*p*-toluquinaldine hydrochloride with one equivalent of the ammonium salt of the Armstrong and Lowry acid, under appropriate conditions, a nearly quantitative separation of *d*-tetrahydro-*p*-toluquinaldine-*d*-*αβ*-bromocamphorsulphonate is obtained; the salt gives the value $[M]_D + 445°$ in aqueous solution. On treating the base retained by the mother liquors with Kipping and Pope's *d*-bromocamphorsulphonic acid, nearly the whole of the *l*-base can be separated in a pure state as described by Pope and Rich.

The molecular rotatory powers of a number of salts of the optically active bases have been examined and found to be in agreement with previous conclusions concerning these values for salts of strong optically active bases with strong acids.

13. "*Note on the Theory of Valency.*" By WILLIAM BARLOW and WILLIAM JACKSON POPE.

The homogeneous, close-packed assemblages of spheres corresponding to a series of homologous compounds, such as, for instance, the normal paraffins, are characterised by similarity of marshalling. Further, the assemblage representing ethane is derived from that of methane (*Trans.*, 1906, lxxxix., 1743) by an application of the second geometrical property (*loc. cit.*, 1729); the substitution of one carbon sphere of volume 4 for a hydrogen sphere of volume 1 in each unit, CH_4, of the partitioning of the methane assemblage necessitates the simultaneous addition of three hydrogen spheres in accordance with the second geometrical property, so that each unit of the ethane partitioning assumes the composition C_2H_6.

The empirical compositions, CH_3 and CH_4, of the ethane and methane assemblages differ, however, by one hydrogen sphere, and a case is thus provided in which, so far as the packing of the spheres is concerned, two hydrogen spheres of volume 1 in the methane assemblage perform the functions of one hydrogen sphere of volume 1 in the ethane assemblage. This is therefore a case of the kind which Mr. D. L. Chapman (*Proc.*, 1906, xxii., 320) considers to offer difficulty in connection with our theory of valency, and to necessitate some modification of the fundamental assumptions. From the fact that the methane and ethane assemblages are related through the second geometrical property, it is, however, clear that the application of Mr. Chapman's argument to an actual instance merely brings out the very close correspondence between the geometrical properties in question and our knowledge of chemical constitution.

Just as the bearings of the doctrine of valency on constitution and substitution do not appear when empirical compositions are considered, so the second geometrical property only serves to elucidate the doctrine of valency when it is applied in connection with the molecular composition, or the composition of the unit of the geometrical partitioning of the assemblage. A number of examples of the mode in which the property is applied have been already given (*loc. cit.*, 1729—1736).

We may perhaps be allowed to take this opportunity of emphasising the statement (*loc. cit.*, 1691 and 1698) that the geometrical properties and the assemblages, which latter are for diagrammatic purposes represented as if composed of undeformed spheres, are in every case supposed to be subject to the condition that so much general pressure is operative on the system as practically to eliminate the interstitial space. It is, of course, not conceivable that the space occupied by the spheres of influence of a group of atoms in contact should include space unavailable for occupation by the atoms.

(To be continued).

NOTICES OF BOOKS.

The Principles of Qualitative Analysis. By Wilhelm Böttger. Translated by William Gabb Smeaton. London: Rebman, Ltd. 1906.

Under favourable conditions the teaching of qualitative analysis may become a valuable training and mental discipline, and Prof. Böttger's book is well adapted to aid the teacher to expound the subject in a thoroughly scientific manner and in accordance with modern conceptions. Much attention is paid to the electrolytic theory and the law of mass action, the fundamental law governing chemical equilibria. The plan adopted in the earlier part of the book, which treats of testing a solution for metals, is to explain, first of all, the method of identification of one metal, and then give directions for the preparation of a solution of a salt of it, with which the reactions and properties of the metallic ion may be studied. This appears a very satisfactory procedure, and should give the student help in acquiring a good grasp of the general tests for each group and the distinguishing reactions of each metal of the groups. The anions are then similarly dealt with, a more systematic classification being adopted than is generally put before the student. The method of attacking the complete analysis of one unknown is also discussed, and general analysis tables are given. The book appears to be more adapted to the requirements of teachers than of students, or at any rate to be used by the latter not in the laboratory, but as a supplement to a simpler text-book of qualitative analysis; there can be, however, no question that it is a particularly valuable treatise on the general principles and methods.

A Laboratory Course of Organic Chemistry. By Arthur W. Titherley, D.Sc. (Vict.), D.Sc. (Liv.), Ph.D. (Heidelb.). London: George Philip and Son, Ltd. Liverpool: Philip, Son, and Nephew, Ltd. 1906.

This book contains directions for general practical work in organic chemistry, including both preparations and the isolation and identification of the more common organic compounds. The course is graduated in difficulty, and begins with the description of simple manipulations and processes, with which, we may remark in passing, the student's inorganic work would probably have made him familiar. Fractional distillation is well explained, and full directions are given for the preparation of many important or typical substances, a good feature being the mention of the yield which should be obtained if the processes are carried out according to the detailed explanations. The experiments on the identification of the more representative classes of compounds are very systematically arranged, and the book should be a useful supplement to lecture-work on elementary organic chemistry. The alkaloids are especially well treated, and the author shows himself to be fully qualified to assist in bringing into instruction in organic chemistry some of that system which at present it generally lacks, and the want of which makes it compare unfavourably with inorganic chemistry as an educational training in the eyes of many teachers.

John Dalton. By J. P. Millington, M.A., B.Sc. London J. M. Dent and Co. New York: E. P. Dutton and Co. 1906.

The account of the struggles of John Dalton against adverse circumstances in his early years is to modern chemists encouraging reading, when they reflect on the outcome of his patience and perseverance, and the student of science does not live who could find these biographical sketches of English men of science dull or uninspiring. The steps by which Dalton arrived at his great generalisation are traced with marked lucidity in this volume, and the elaboration of his views regarding the atomic structure of matter is critically surveyed, while his marvellous power of marshalling his facts and making deductions from them is clearly set forth. His experimental work is perhaps somewhat undervalued, for he undoubtedly acquired a considerable amount of dexterity, especially in the handling of gases, though it cannot be disputed that it was as a thinker that he made his greatest mark; nevertheless, if it had not been for his remarkable achievements in this direction in all probability his experimental work would have been more appreciated, and he certainly possessed a unique talent for the collection of material upon which to base his theories. The present time, when speculations as to the nature of matter are rising on every side, is well fitted for the publication of this excellent little biography of our great chemist, who was so well equipped from a physical point of view to lay the foundations of modern physical chemistry.

Die Fabrikation des Russes und der Schwärze. ("The Manufacture of Soot and Carbon Blacks"). By Dr. Hippolyt Köhler. Second Edition. Braunschweig: Friedrich Vieweg und Sohn. 1906.

The author of this small book has had much experience in the manufacture of carbon blacks, and his opinion, especially upon practical points, is of great value. The subject is treated more particularly from the point of view of the utilisation of by and waste products, and the production of decolorising charcoal is considered at length. In the second edition the first part is practically unchanged, although a chapter has been added on advances in the making of soot during the last twenty years. The second part of the book, on the other hand, has necessarily been much extended owing to the variety of new processes which have come into use in the manufacture of carbon blacks. A section on the examination and valuation of soot and carbon blacks describes all the usual methods, and an attempt is made to give practical methods for the identification and separation of the different products. Colour tests and the measurement of colouring power are treated only briefly, and the second on methods of examination might perhaps have been somewhat enlarged with advantage.

Untersuchungen über Künstliche Parthenogenese. ("Researches on Artificial Parthenogensis"). By Jacques Loeb. German Edition by E. Schwalbe. Leipzig: Johann Ambrosius Barth. 1906.

The German translation of Prof. Loeb's work on Parthenogenesis has been prepared with the sanction and help of the author, who has contributed to it a preface, in which he briefly describes the aim and scope of the book. In order to get an insight into the essential nature of fertilisation he believes that the chemical and physical agents which influence it must first be sought, and that then their action must be further and more accurately investigated. The author's experiments are not yet by any means concluded, but the account of them, so far as they go, makes a book which all biologists will be glad to read, even if many of them dissent from the conclusions drawn in it. The translation has been carefully performed, and the sense of the original has been faithful reproduced.

Gmelin-Kraut's Handbuch der Anorganischen Chemie. ("Gmelin and Kraut's Handbook of Inorganic Chemistry"). Edited by A. Hilger and C. Friedheim. Seventh Edition. Heidelberg: Carl Winter. 1905.

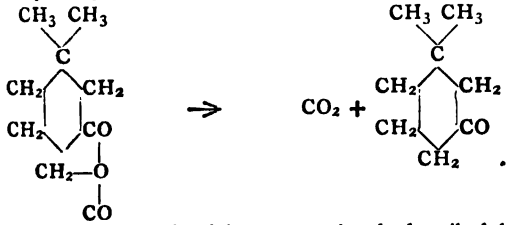
The seventh edition of Gmelin and Kraut's text-book of inorganic chemistry, which is now in course of publication, is one of the most comprehensive and thorough works on the subject which has ever been produced, and possesses many distinctive characteristics, which will recommend it as a reference book and dictionary of chemistry. Hardly any other work can approach it in completeness and in the abundance of references to original papers, and the arrangement of the great mass of material which the authors have accumulated is most convenient. The text-book is to appear in 70 parts, and the editors hope that the publication of the seventh edition will be completed in the course of the years 1908 or 1909.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

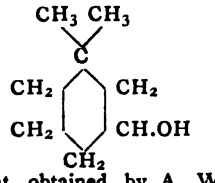
Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 3, January 21, 1907.

Conditions of Stability of the Carbylamines.—H. Guillemard.—This author has previously indicated methods that may be employed for the estimation of mixtures of nitriles and carbylamines. On applying these methods to the investigation of the alcoholisation of metallic cyanides, he finds that, if, in numerous instances, carbylamines are not obtained, the fact is to be explained by the conditions of the experiment either giving rise to isomerism with their transformation into nitriles, or causing their combination with some body present to form compounds incapable of generating them, or causing decomposition. From the facts collected experimentally, the conclusion is, on the one hand, that the carbylamines tending to form themselves may disappear by combining readily with the agents of alcoholisation, which give rise to them, if they are not isolated in the state of stable combination with the cyanide; on the other hand, that they readily form isomers under the influence of heat, after having given rise to an intermediate compound, which might be a combination with a cyanide or a polymer able itself to change to a nitrile. It is thus manifest that a carbylamine is not obtained by alcoholising a cyanide, if the latter is able to form a stable combination with the nascent carbylamine.

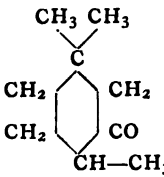
Synthesis of Derivatives of Cyclohexane : 3.3-Dimethyl and 3.3.6-Trimethylcyclohexanones.—G. Blanc.—The author has previously demonstrated that $\beta\beta$-dimethyl and $\beta\beta\varepsilon$-trimethylpimelic acids may be obtained synthetically by a series of reactions. These two acids readily close their chain with loss of CO_2, furnishing the corresponding hexanones, the process being the well-known classical method of calcination of the calcium salt. The author found it most practical to transform the acid into the anhydride by means of acetic anhydride, distilling the latter slowly at the ordinary pressure. The reaction then takes place quantitatively into CO_2 and cyclohexanone.



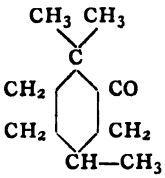
$\beta\beta$- (or 3.3) dimethylcyclohexanone, already described by Léser, who obtained it by treating acetylcyclomethylheptenone with aqueous potash, is a colourless mobile liquid with an odour of menthone; it boils at 173°. Its semicarbazone crystallises in dilute alcohol in needles fusing at 203° over mercury. Reduced by sodium and absolute alcohol it is converted into an alcohol—



identical with that obtained by A. W. Crossley and N. Renouf, starting from 1.1-dimethyldihydroresorcin. This alcohol is an oily liquid with a camphor-like odour, boiling at 78° (15 mm.), solidifying in ice, and then melting towards 12°. The slow distillation of $\beta\beta\varepsilon$-trimethyl pimelic anhydride leads similarly to $\beta\beta\varepsilon$- (or 3.3.6) trimethylcyclohexanone, the constitution of which is similar to that of the pulenone of Wallach and Kempe:—



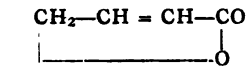
3.3.6-Trimethyl-cyclohexanone.



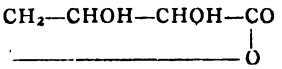
Pulenone.

This new ketone is a mobile liquid with a strong odour of menthone, boiling at about 186°; its semicarbazone melts at 170° over mercury.

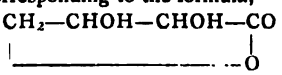
Synthesis of Natural Erythrite.—R. Lespieau.—The author has previously notified the formation of buteneolide—



from the nitrile produced by the action of hydrocyanic acid upon epichlorhydrin, and the further production of an erythronic lactone—



The compound thus obtained has no action upon polarised light, but the presence within the molecule of two asymmetric carbon atoms, not mutually neutralising each other, led to the supposition that the inactivity was due to the presence of optical inverses in equimolecular proportions. On the other hand, if stereochemically four bodies can be represented corresponding to the formula,—



it is obvious that only two of them could arise from the fixation of two hydroxyls upon butene-2-olide, those two being those in which the hydroxyls are on the same side of the plane of the ring corresponding to this closed chain. Thus hydrolysis of the inactive lactone would give inactive erythrite on this supposition. The author has verified these consequences of stereochemistry by changing the inactive lactone (1) to a levorotatory lactone, (2) to natural erythrite. The synthesis completely agrees with the stereochemical views. The lactone, which formed the starting point, belonged to the maleic series.

MISCELLANEOUS.

Royal Institution.—A General Monthly Meeting of the Members of the Royal Institution was held on the 4th instant, Sir James Crichton-Browne, M.D., F.R.S., Treasurer and Vice-President, in the Chair. Sir David Gill, K.C.B., Mr. S. A. Ionides, The Hon. George Peel, and Mr. H. M. Phipson were elected Members. The Special Thanks of the Members were returned to Dr. Ludwig Mond, F.R.S., for his Donation of £300, and to Professor Sir James Dewar, F.R.S., for his Donation of £100 to the Fund for the Promotion of Experimental Research at Low Temperatures.

The Rothamsted Experimental Station (Lawes Agricultural Trust) has received a donation of £2000 from the Permanent Nitrate Committee, to be invested and added to the general endowment fund of the Station. A donation of one hundred guineas has also been received from the Fertiliser Manufacturers' Association. During the past summer the Station entered into occupation of the "James Mason" Bacteriological Laboratory, the gift of Mr. J. F. Mason, M.P. The Society for extending the Rothamsted Experiments, which was formed to obtain funds wherewith the Experimental Station might enlarge the scope of its work and initiate further agricultural in-

vestigations, has further received, during the past year, subscriptions and donations amounting to £240. Further subscriptions are still urgently needed to secure a more adequate staff, and may be addressed to the Secretary of the Rothamsted Experimental Station, Harpenden, Hertfordshire.

Manufacture of Paints and Colours.—The Chief Inspector of Factories forwards a copy of the Regulations made by the Secretary of State for the Manufacture of Paints and Colours. They will apply, except where otherwise indicated in the Regulations, to all factories and workshops engaged in that manufacture in which dry carbonate of lead or red lead is used, or chromate of lead is produced by boiling. The Regulations came into force on the 1st February, 1907, and supersede the Special Rules for the manufacture of paints and colours established under the Factory and Workshop Act, 1891. A copy of the Regulations must be kept affixed in a conspicuous place in every factory and workshop to which they apply. Under Regulations 4 and 11 every person employed in a "lead process," or at the roller mills connected with the grinding in oil of "lead colour," must be medically examined once in each calendar month *at the appointed time* by the Certifying Surgeon of the district, unless some other medical practitioner is specially appointed for the purpose by the Chief Inspector of Factories. The time appointed for examination must be made known to all workers concerned, and arrangements should be made for due privacy. The Surgeon will be required to forward annually to the Home Office a return of the examinations and suspensions during the year.

Some Sulphates of Tetravalent Vanadium.—Gustave Gain.—MM. Koppel and Behrendt have obtained a certain number of vanadyl sulphates by dissolving V_2O_5 in concentrated sulphuric acid and reducing the solutions with SO_2. Other sulphates belonging to the same group have been prepared by the author according to a different method, which starts from the azure-blue solution, obtained by treating the mixture of V_2O_3 and V_2O_4 with a saturated solution of SO_2. By different treatments, the following sulphates were isolated and analysed :—

$2V_2O_4.5SO_3.18H_2O$	Azure-blue crystals
$2V_2O_4.6SO_3.20H_2O$	Turquoise-blue crystals
$2V_2O_4.7SO_3.20H_2O$	Blue-green crystals
$2V_2O_4.9SO_3.22H_2O$	Clear blue crystals
$2V_2O_4.10SO_3.24H_2O$	Very clear blue crystals

These may be written in the following series :—

$$2SO_4(VO)+3H_2SO_4+16H_2O,$$
$$2SO_4(VO)+4H_2SO_4+16H_2O,$$
$$2SO_4(VO)+5H_2SO_4+15H_2O,$$
$$2SO_4(VO)+7H_2SO_4+15H_2O,$$
$$2SO_4(VO)+8H_2SO_4+16H_2O.$$

—*Comptes Rendus*, cxliii., No. 26.

Method of Determining Transition-points.—K. Beck and K. Ebbinghaus.—If a substance which can exist in different modifications in the solid state is fused in a test-tube, and the melt is put after solidification into a cooling bath (a beaker full of water), as the temperature gradually sinks a visible change occurs in the structure of the melt. At a temperature a little below the melting point the walls of the test-tube appear to be completely covered with a deposit of crystals, but as the temperature falls this deposit detaches itself from the glass walls, often with a crackling noise. It was found that there is a definite temperature above which the deposit is visible and below which the substance separates off from the walls. From a great number of experiments it was concluded that this peculiarity of change of structure is widely distributed, so that a method of characterising and identifying substances can be based upon it. The authors experimented with sulphur, ice, benzophenone, *p*-dibrombenzene, *p*-dichlorbenzene, &c. ; also with mixtures of the last two named compounds. The experiments with sulphur were performed in order to test the method with reference to the transition S rhombic $\rightleftharpoons$ S monoclinic. The transition-point is 95·5°, *i.e.*, below this temperature the rhombic form is stable and above it the monoclinic modification is stable. With rhombic sulphur it was found that from 25° to 90° the glass walls were quite clear, at 95° traces of a deposit were seen, at 96° it was more distinct and rapidly increased, and at 115° the specimen had not melted, but it melted at 120° to 121°. The heating was arranged so that the increase of temperature was 1° in every forty-five seconds. These experiments were repeated many times, and it was found that the method affords a convenient means of determining the transition-point.—*Berichte*, xxxix., No. 15.

MEETINGS FOR THE WEEK.

MONDAY, 11th.—Society of Arts, 8. (Cantor Lectures) "Gold Mining and Gold Production," by Prof. J. W. Gregory.

TUESDAY, 12th.—Royal Institution, 3. "The Visual Apparatus of Man and Animals," by Prof. William Stirling.

WEDNESDAY, 13th.—Society of Arts, 8. "Motor Omnibuses," by Lord Montagu of Beaulieu.

THURSDAY, 14th.—Royal Institution, 3. "The Minute Structure of Igneous Rocks and their Significance," by Mr. A. Harker.

—— Society of Arts, 4.30. "The Practical Side of Famine in India," by Sir Frederic S. P. Lely.

FRIDAY, 15th.—Royal Institution, 9. "Foraminifera," by Mr. J. J. Lister.

SATURDAY, 16th.—Royal Institution, 3. "Röntgen, Cathode, and Positive Rays," by Prof. J. J. Thomson.

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CHEMISTRY	ALEX. MCKENZIE, Ph.D., D.Sc, M.A.
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BOTANY	V. H. BLACKMAN, M.A.
ZOOLOGY	H. W. UNTHANK, B.A., B.Sc.
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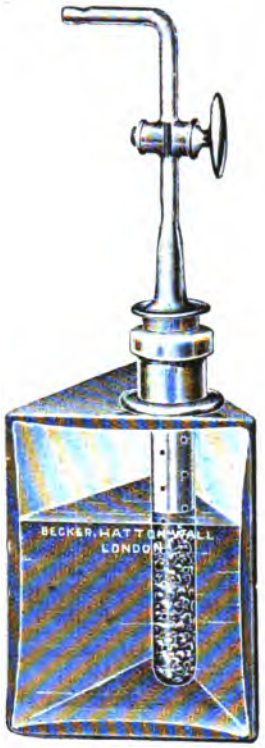

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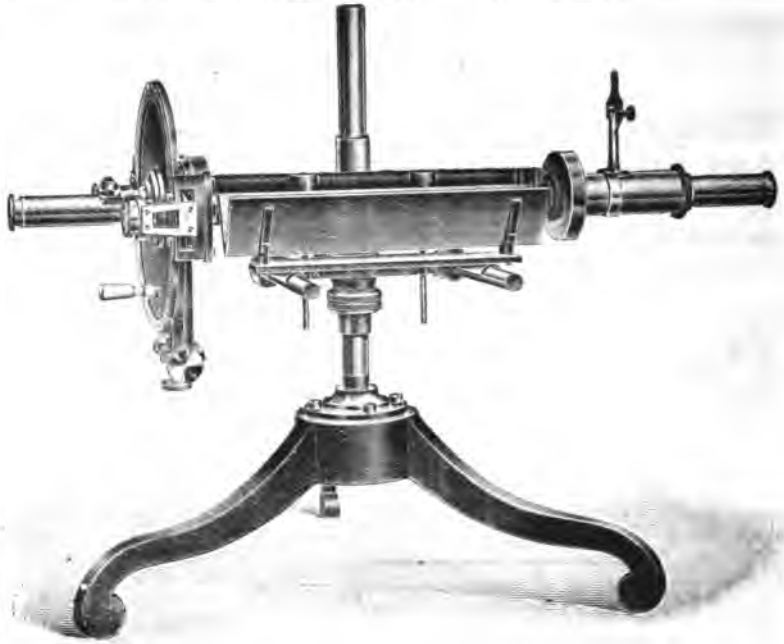

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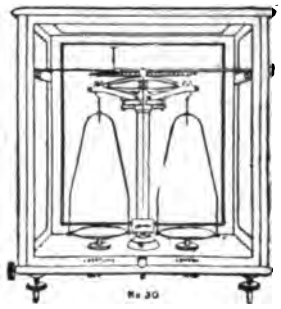

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THE CHEMICAL NEWS.

Vol. XCV., No. 2464.

BORIC ACID: ITS DETECTION AND DETERMINATION IN LARGE OR SMALL AMOUNTS.*

By WILSON H. LOW.

(Concluded from p. 62).

Quantitative Test (continued).

The following results are from an actual test:—Fifty grms. of meat taken + 25 cc. N/2 sodium carbonate solution.

First distillate, about 100 cc. After making alkaline to nitrophenol, took about 5·90 cc. N/1 sodium hydroxide to phenolphthalein end-point. Enough to make in all 17·7 cc. of the N/1 sodium hydroxide were added. After evaporating off the alcohol and getting the residue in proper solution, the titration for boric acid took 4 cc. of N/1 sodium hydroxide + 21·7 cc. N/10 sodium hydroxide, equivalent to 61·70 cc. N/10 solution in all. Deduct 0·25 cc. for the glycerol blank leaves 61·45 cc. as due to the boric acid in the first 100 cc. of distillate.

The boiling and distillation flasks are set on asbestos cloth and held in retort rings and clamps.

The apparatus works perfectly and I cannot say too much about the absolute necessity of the boiling tube at every stage where methyl alcohol is boiled in glass. In a metal dish it will boil without bumping, but not in glass. The boiling flask has some phenolphthalein added to it and enough concentrated sodium hydroxide (practically carbonate-free) to keep it permanently red. This insures no boric acid in the vapour.

All stoppers are of cork.

Second distillate, about 100 cc., took 6 cc. N/10 sodium hydroxide, for the boric acid. This minus 0·25 for the glycerol blank leaves 5·75 cc. for the boric acid. The preliminary titration in methyl alcohol solution had indicated about 5·50 cc.

Third distillate, about 100 cc., took 0·57 cc. N/10 sodium hydroxide, and this minus 0·25 cc. for the glycerol blank leaves 0·32 cc. for the boric acid.

Fourth distillate, about 50 cc., took 0·25 cc. N/10 sodium hydroxide, and this is the quantity taken by the glycerol alone, so all the boric acid has been obtained.

Total N/10 sodium hydroxide used for boric acid = 67·52 cc. and this multiplied by 0·0062 = 0·4168 grm. = 0·837 per cent. on the meat taken.

This is a large quantity to be present under the circumstances and was more than I expected. Had it not been for the preliminary titration in methyl alcohol solution, enough alkali to retain the boric acid might not have been added and loss would have occurred while evaporating off the methyl alcohol. Had more calcium chloride been added at the start the first two distillates would probably have contained all the boric acid.

Action of Boric Acid on some Indicators.—In all the following experiments, unless otherwise stated, the water used was free from carbon dioxide.

A solution of more than 2 grms. of boric acid in 100 cc. will react acid to methyl orange and also to nitrophenol, more so to the latter than the former. Direct experiments have shown, however, that nitrophenol gives perfectly accurate results in boric acid titration, if carried out as directed. It is a great advantage to expel all carbon dioxide, and this applies to methyl orange as well.

Loss of Boric Acid on Ignition with Organic Matter.—On igniting boric acid and meat, strongly, to burn off as much carbon as possible, greenish flames were seen, and the ash when tested gave a very slight qualitative test for boric acid, while there had been enough originally present to give a strong test.

Numerous experiments have been made to test the process at every essential point. Instead of giving the experiments in detail it will, perhaps, be sufficient to give in direct statements the results.

1. A solution containing a small amount of boric acid may be concentrated from 100 cc. to 10 cc. without fear of a titratable amount of boric acid being lost.

2. Boiling a dilute solution of boric acid to free it from carbon dioxide occasions no loss, unless the boiling is prolonged.

3. All carbon dioxide is expelled from distilled water by heating to boiling and then applying vacuum for a few minutes till the solution is almost cold.

4. Starting with a mixture in the distillation flask of 25 cc. of water and 25 cc. of methyl alcohol and passing methyl alcohol vapour through the mixture, while keeping the latter approximately at the same volume, it took fifty-five minutes and over 400 cc. of distillate before the temperature of the vapour leaving the distillation flask was anywhere near the boiling-point of methyl alcohol, showing the difficulty of driving off the water.

5. Ten cc. of boric acid solution containing 0·3125 grm. and 40 cc. methyl alcohol were distilled with methyl alcohol vapour. Seven successive distillates failed to get over all the boric acid.

6. Where a water trap was not used the boric acid recovered was, in a certain case, equivalent to 4·90 cc. N/1 sodium hydroxide. Where a water trap was used 5·05 cc. N/1 sodium hydroxide were required. Theory called for 5·04 cc.

7. By distilling a mixture of one volume of aqueous solution of boric acid with ten volumes of methyl alcohol, till only 3 cc. of the mixture were left, about four-fifths of the boric acid were found in the distillate and one-fifth left in the flask.

8. It was found that if calcium chloride was added to the distillation flask in the proportion of about 0·5 grm. for each cubic centimetre of solution, all the boric acid came over quickly and completely. Using two-thirds of a grm. of calcium chloride is better yet, unless some conditions make it impracticable to use this amount.

Notes.

Make sure the methyl alcohol and calcium chloride used give no distillate containing a titratable quantity of boric acid. This may be insured by placing the calcium chloride in a separate flask, connecting with the distillation apparatus, acidifying with several drops of hydrochloric acid, and passing methyl alcohol vapour through till the distillate gives no titration for boric acid. This solution of calcium chloride is then added to the test instead of the solid salt. Nickel dishes or deep crucibles are very good for evaporating off alkaline solutions of methyl alcohol containing boric acid. No boiling tube is required. While our method of freeing the solution from carbon dioxide, by boiling under a vacuum after heating on the steam-bath, appears all that could be desired, it is not suitable for freeing a solution of calcium bicarbonate from excess of carbon dioxide. Actual boiling under atmospheric pressure is required in this case as direct experiments have shown.

Sometimes iron appears to distil over with the methyl alcohol, when the contents of the distillation flask are strongly acid. This causes the end-point with nitrophenol to be somewhat obscure, as the solution will take on a reddish tinge before the strong yellow due to excess of alkali. It makes the solution look as if the phenolphthalein end-point was about to be reached, before the nitrophenol end-point had been seen. This has only occurred a few times and did little harm. This was noticed so recently, that I have not proved it to be caused by iron, but it appears to be iron.

* From the *Journal of the American Chemical Society*, xxviii., No. 7.

In conclusion, I would like to draw attention to the very wide distribution of boric acid. It occurs in almost everything we meet in the food line, and caution should be used in reporting food as containing boric acid as a preservative without a quantitative determination. Ten grms. of food product are quickly burned to ash and 50 to 100 cc. of methyl alcohol distilled from this ash will contain most of the boric acid, or even all, unless it is present in some quantity. Now one drop of N/10 sodium hydroxide on this quantity will equal 0·0031 per cent. of boric acid, much too small a quantity to have been added for preserving purposes, and yet large enough to have given a strong qualitative test.

Boric acid occurs naturally in apples and probably in other fruits and vegetables. It is present in almost all common salt and some kinds contain relatively considerable amounts of it.

Below will be given some results on salts used in packing-house products. The results are rather under than over the truth, as some of the tests were made without all the necessary refinements of the process as it now stands.

Designation of the salt.	Boric acid. Per cent.	Grains per pound avoir.
Kansas No. 2 rock salt ..	0·005000	0·35
Foreign sea salt	0·010900	0·76
Foreign sea salt	0·006448	0·45
Cheshire salt	0·000992	0·07
XXX Casing salt	0·000620	0·0435
Kansas fine salt	0·000620	0·0435
Kansas rock salt, No. 2 ..	0·001240	0·0870
Louisiana rock salt	0·000992	0·06944

There is not a salt here but what would give a good qualitative test by the delicate method indicated in this paper, and some of them would show up under the less refined test of the steam-bath.

PRESENTATION TO PROFESSOR RIGHI.

A CIRCULAR, of which the following is the English version, has been sent in English, Italian, French, and German, by an influential Committee, to all men of science likely to be interested in the work which Professor Righi has so successfully carried on for twenty-five years.

SIR,—It is both right and just that those men of highest merit, who by their genius and doctrine have added to the patrimony of science and have opened up new ways to the progress of humanity, should feel and see how much esteem and affection has sprung up and grown around them, slowly and yet vigorously, perhaps without their having perceived how much they are esteemed and loved.

A few friends and admirers wish that this should be so in regard to Senator Professor Augusto Righi. They have therefore thought of celebrating by a ceremony which is to be kept strictly intimate, as such is more counted to please the illustrious professor, the 25th anniversary of his university teaching, together with the occasion of the transferment to a worthier site of the Physical Institute, over which he presides and renders each day more glorious.

This ceremony will take place the day on which he will deliver his first lecture at the new Institute, and will consist in the presentation of a bronze bust, to perpetuate throughout future generations the likeness, and through their means the gifts of vigor in intellect and soul that the beloved Master reveals in his features.

We beg to announce that the ceremony will take place February 20th in the certainty that the adhesion of one so well-known in science as yourself would be most welcome to Professor Righi.

THE COMMITTEE.

Bologna, R. Università.
January 20th, 1907.

THE CARRYING DOWN OF AMMONIUM OXALATE BY OXALATES OF THE RARE EARTHS.*

By GREGORY PAUL BAXTER and ROGER CASTLE GRIFFIN.

(Concluded from p. 64).

NEODYMIUM oxalate, which had been precipitated by addition to a nearly saturated solution of ammonium oxalate, was found to contain a still larger proportion of ammonium oxalate.

	I.	II.	III.	Average.
Per cent of Nd_2O_3	49·56	49·70	49·59	49·62
Per cent of C_2O_3	39·63	39·66	39·66	39·65
Per cent of $H_2O + NH_3$ ..	9·91	10·31		10·11
Total..				99·38

$$\text{Ratio, } M_2O_3 : 3C_2O_3 = \frac{49·62}{39·65} = 1·2514$$

$$M = 111·2 \quad (Nd = 143·6)$$

Upon the assumption that the average atomic weight of the metals in this sample is 144·2, the amount of C_2O_3 corresponding to 49·62 per cent of oxide is 31·86. The difference between this proportion and that observed is 7·79, which in turn corresponds to 3·68 per cent of ammonia. In order to determine whether this proportion of ammonia actually existed in the oxalate, the latter was analysed for ammonia. Weighed portions of the oxalate were dissolved in dilute sulphuric acid, and the solutions were diluted to about one-half litre. Then they were transferred to a litre retort, into the tubulature of which was fitted a dropping funnel containing a strong solution of ammonia-free potassium hydroxide. The potassium hydroxide was slowly added to the solution in the retort, and the ammonia set free was distilled into standard hydrochloric acid in the usual way. Blank tests were made, and slight corrections were applied. The percentage of ammonia obtained experimentally agrees very closely with that calculated above.

	I.	II.	III.	IV.	Average.
Weight of oxalate..	0·4343	0·2872	0·3290	0·3098	
Cc. N/10 HCl used .	9·22	6·10	6·76	6·46	
Per cent of ammonia	3·61	3·62	3·55	3·55	3·58
Calculated..					3·68

Next, precipitation in neutral solution with ammonium oxalate was investigated. A solution of neodymium chloride as nearly neutral as possible was prepared by evaporating to dryness on the steam-bath a solution of the oxide in hydrochloric acid, and repeating the evaporation several times after dissolving the residue in water. This solution was added drop by drop with continual agitation to a concentrated hot solution of ammonium oxalate. Occlusion is to be expected to the same extent here as in the previous case. Such proved to be the result.

	I.	II.	III.	Average.
Per cent of Nd_2O_3	49·57	49·49		49·53
Per cent of C_2O_3	39·25	39·24	39·25	39·25
Per cent of $H_2O + NH_3$ ..	11·28	11·74		11·51
Total..				100·29
Per cent of NH_3	3·50	3·50		3·50
Per cent of C_2O_3 corresponding to NH_3				37·41
Per cent of C_2O_3 corresponding to Nd_2O_3 ..				31·84

$$\text{Ratio, } M_2O_3 : 3C_2O_3 = \frac{49·53}{31·84} = 1·5555$$

$$M = 144·0 \quad \text{Theoretical} = 144·2$$

It has been pointed out by Richards that occlusion of any substance is proportional to the concentration of that

* From the *Journal of the American Chemical Society*, xxviii., No. 12.

substance in the molecular condition at the moment of precipitation (*Proc. Am. Acad.*, xxxv., 377; xxxvi., 377). In the present instance, since ammonium oxalate is the substance occluded, occlusion should increase with increasing concentration of molecular ammonium oxalate at the moment of precipitation. This has already been found to be the case when precipitation is carried out in neutral or very nearly neutral solution. In a solution containing much strong acid, however, the concentration of molecular ammonium oxalate would be very low, for the reaction between the hydrogen ion and the oxalate ion is nearly complete, even when the hydrogen ion concentration is not large. In the case of nitric acid the equilibrium with ammonium oxalate may be represented as follows:—

$$\begin{array}{ccc} 2NH_4^+ + C_2O_4^{--} & \rightleftarrows & (NH_4)_2C_2O_4 \\ + \quad + & & \\ 2NO_3^- + 2H^+ & \rightleftarrows & 2HNO_3 \\ \uparrow\downarrow \quad \uparrow\downarrow & & \\ 2NH_4NO_3 \quad H_2C_2O_4. & & \end{array}$$

If then neodymium oxalate is precipitated by ammonium oxalate in the presence of much nitric acid, little or no carrying down of ammonium oxalate is to be expected.

In the next experiment neodymium nitrate was added to a hot nearly saturated solution of ammonium oxalate containing a large amount of nitric acid. The precipitate was washed with hot water, dried, powdered, and analysed as before. The analysis of the precipitate confirms the prediction made above. The precipitate contained a mere trace of ammonia, which may account for the slight difference between the observed and theoretical results.

	I.	II.	Average.
Per cent of Nd_2O_3 ..	52·73	52·73	52·73
Per cent of C_2O_3 ..	33·90	33·91	33·91
Per cent of H_2O ..	12·39	12·53	12·46
Total..			99·10

$$\text{Ratio, } M_2O_3 : 3C_2O_3 = \frac{52·73}{33·91} = 1·5551$$

M = 144·0 Theoretical = 144·2

Praseodymium oxalate also was studied in the same way. To a solution of praseodymium nitrate containing nitric acid, an excess of oxalic acid solution was added, drop by drop, with continual agitation. The oxalate, was thoroughly washed with water, dried in an air-bath, powdered in a mortar, and analysed as in the case of neodymium. The oxalate, upon ignition, was eventually converted into a black oxide, of the composition Pr_4O_7 (Dammer, *Handb. der Anorg. Chem.*, iii., 42).

	I.	II.	III.	IV.	Average.
Ratio, Pr_4O_7: oxalate	58·50	58·56			58·53
Per cent of Pr_2O_3 ..	57·12	57·17			57·15
Per cent of C_2O_3 ..	37·41	37·24	37·17	37·23	37·26
Per cent of H_2O ..	6·42	6·23			6·33
Total..					100·74

$$\text{Ratio, } Pr_2O_3 : 3C_2O_3 = \frac{57·15}{37·26} = 1·5338$$

Pr = 141·7 Theoretical = 140·5

The difference between the experimental and theoretical values for the atomic weight of praseodymium may be due to uncertainty either as to the purity of the material employed or as to the composition of the oxide formed by ignition of the oxalate.

A solution of the same praseodymium material containing only a very slight excess of nitric acid was then precipitated by addition to a hot concentrated slightly ammoniacal solution of ammonium oxalate. Precipitation was complete. The precipitate contained very nearly as much ammonia as neodymium oxalate when precipitated under the same conditions.

	I.	II.	III.	Average.
Ratio, Pr_4O_7: oxalate ..	50·48	50·53		50·51
Per cent of Pr_2O_3	49·28	49·33		49·31
Per cent of C_2O_3	38·98	39·01		39·00
Per cent of NH_3	3·45	3·40	3·45	3·43
Per cent of C_2O_3 corresponding to 3·43 per cent of NH_3				7·27
Per cent of C_2O_3 corresponding to Pr_2O_3				31·73

$$\text{Ratio, } M_2O_3 : 3C_2O_3 = \frac{49·31}{31·73} = 1·5541$$

M = 143·8 Theoretical = 140·5

The yttrium material employed proved to be far from pure, the atomic weight determined with the precipitate from acid solution being 102·9, while the atomic weight of yttrium is 89·0. Yttrium oxalate was precipitated by adding a solution of a slight excess of oxalic acid to an acid solution of the nitrate, and by adding a nearly neutral solution of the nitrate to a large excess of ammonium oxalate. The precipitate formed in the latter fashion proved to contain considerable ammonia, but when a correction is applied for this ammonia, both precipitates yield nearly the same result for the atomic weight of the sample.

Acid Precipitation.

	I.	II.	Average.
Per cent of Y_2O_3 ..	46·24	46·31	46·28
Per cent of C_2O_3 ..	39·37	39·39	39·38
Per cent of H_2O ..	14·48	14·64	14·56
Total..			100·22

$$\text{Ratio, } M_2O_3 : 3C_2O_3 = \frac{46·28}{39·38} = 1·1750$$

M = 102·9

Neutral Precipitation with Ammonium Oxalate.

	I.	II.	Average.
Per cent of Y_2O_3	41·22	41·25	41·24
Per cent of C_2O_3	44·84	44·97	44·91
Per cent of NH_3	4·54	4·53	4·53
Per cent of C_2O_3 corresponding to 6·95 per cent of NH_3			9·59
Per cent of C_2O_3 corresponding to Y_2O_3 . ..			35·32

$$\text{Ratio, } M_2O_3 : 3C_2O_3 = \frac{41·24}{35·32} = 1·1674$$

M = 102·1

The last material investigated was separated from a solution of the rare earths contained in Texas gadolinite by means of fractional precipitation with magnesium oxide. The spectroscope showed it to be rich in erbium, and to contain samarium, while didymium was entirely absent. A portion of the oxalates was soluble in an excess of ammonium oxalate in neutral solution, although in acid solution precipitation was complete, hence undoubtedly ytterbium was present. In order to make certain that the same material was treated both in neutral solution and in acid solution, precipitation with ammonium oxalate in neutral solution was carried out first, and then, after the precipitate had been analysed, the same material was dissolved and precipitated with oxalic acid in the presence of considerable nitric acid.

Acid Precipitation.

	I.	II.	III.	Average.
Per cent of M_2O_3.. ..	54·64	54·63	54·63	54·63
Per cent of C_2O_3.. ..	34·94	34·94	34·96	34·95

$$\text{Ratio, } M_2O_3 : 3C_2O_3 = \frac{54·63}{34·95} = 1·5633$$

M = 144·9

Neutral Precipitation with Ammonium Oxalate.

	I.	II.	Average.
Per cent of M_2O_3 ..	47·88	47·80	47·84
Per cent of C_2O_3 ..	40·05	40·04	40·05

$$\text{Ratio, } M_2O_3 : 3C_2O_3 = \frac{47·84}{40·05} = 1·1945$$

$$M = 105·0$$

Per cent of NH_3 (calculated, M = 144·9).. 4·47

It is interesting to compute the relation of the number of molecules of the oxalates of the rare earths and of ammonia in the precipitates in which the ammonium oxalate content was at a maximum.

	Per cent of oxide.	Per cent of ammonia.	Per cent of $(NH_4)_2C_2O_4$.	Molecules of $(NH_4)_2C_2O_4$ for one molecule $M_2(C_2O_4)_3$.
Nd_2O_3 ..	49·62	3·58	13·05	0·71
Pr_2O_3 ..	49·31	3·43	12·50	0·68
Y_2O_3 ..	41·24	4·53	16·51	0·82
Er_2O_3(?) .	47·84	4·47	16·29	0·93

The extent of the carrying down of ammonium oxalate by the rare earth oxalates which were investigated is much larger than in other cases of occlusion (Richards, *loc. cit.*; Baxter, *Am. Chem. Journ.*, 1902, xxviii., 298), and leads to the conclusion that the real cause of the phenomenon is not the formation of solid solutions of ammonium oxalate in the rare earth oxalates, as is the case with true occlusion, but the formation of a somewhat unstable double salt, possibly of the general formula $M_2(C_2O_4)_3(NH_4)_2C_2O_4$, analogous to the double salts with potassium and sodium oxalates. In either case the extent of the carrying down of ammonium oxalate by the insoluble oxalates would vary with the concentration of the molecular ammonium oxalate at the moment of precipitation.

Summary.

1. The results of the foregoing investigation show that the insoluble oxalates of neodymium, praseodymium, yttrium, and certain other of the rare earths, exhibit a strong tendency to carry down ammonium oxalate, when precipitation takes place in neutral or nearly neutral solution.

2. In the case of neodymium, it is shown that the amount of ammonium oxalate carried down is dependent upon the concentration of molecular ammonium oxalate at the moment of precipitation.

3. Furthermore, it is shown that neodymium oxalate has no tendency to carry down oxalic acid, and that the occlusion of ammonium oxalate may be prevented by diminishing the molecular concentration of ammonium oxalate in solution by means of a strong acid.

It is probable that occlusion by other rare earth oxalates varies in the same way as in the case of neodymium.

4. It is pointed out that the magnitude of the phenomenon is so great that the most reasonable explanation lies in the assumption of the existence of somewhat unstable double salts, rather than of true occlusion.

It seems probable also that the carrying down of the oxalates of sodium and potassium and of the other alkalis will vary with the conditions of precipitation as in the case of ammonium oxalate.

This question is now under investigation in the laboratory (Harvard College).

Ethyl Benzoylglyoxylate.—A. Wahl.—Ethyl benzoylgloxylate is the second known representative of the series of the α-β-diketonic ethers, the other terms being ethyl acetylglyoxylate or ethyl diketobutyrate. It is obtained from ethyl benzoyl acetate by replacing the methylene with the ketone group—

$$C_6H_5—CO—CH_2—COOC_2H_5 \rightarrow$$
$$\rightarrow C_6H_5—CO—CO—COOC_2H_5.$$

It reacts with hydroxylamine chlorhydrate to give a monoxime, which is identical with ethyl iso-nitrosobenzoylacetate, showing that only the α-carbonyl has entered into the reaction. This, and other reactions, have served to determine its constitution.—*Comptes Rendus*, cxliv., No. 4.

A REVISION OF THE ATOMIC WEIGHT OF COBALT.*

FOURTH PAPER.—THE ANALYSIS OF COBALTOUS CHLORIDE.

By GREGORY PAUL BAXTER
and
FLETCHER BARKER COFFIN.

SOME years ago the atomic weight of cobalt was investigated in the Chemical Laboratory of Harvard College by the determination of the ratios of cobaltous bromide to silver and to silver bromide (Richards and Baxter, *Proc. Am. Acad.*, 1897, xxxiii., 115), and of cobaltous bromide (*Ibid.*, 1899, xxxiv., 351), cobaltous chloride and cobaltous oxide (*Ibid.*, 1899, xxxv., 61) to cobalt. From these investigations the probable value for the atomic weight of cobalt was found to be 58·895 (Ag = 107·930), the most satisfactory results being obtained through the analysis of cobaltous bromide.

The determination of the cobalt in cobaltous chloride was effected by reduction of the salt in a current of hydrogen. The salt was not obtained in a state of absolute purity, and it was necessary to apply corrections for the impurities, so that at the time very little value was attached to the result, 59·072.

(The value found from two analyses was 59·044, upon the assumption that the atomic weight of chlorine is 35·456, Ag = 107·930. Recent determinations in the Chemical Laboratory of Harvard College by Richards and Wells ("Publications of the Carnegie Institution," No. 28, 1905) have shown that the value of the latter constant is as high as 35·473. This change in the atomic weight of chlorine produces an increase in the atomic weight of cobalt of 0·028).

In the present investigation it has been found possible with the help of the newly available quartz apparatus to prepare the salt in a state of greater purity, and the analysis of this new material confirms satisfactorily the previous analyses of cobaltous bromide, as well as the doubt concerning the earlier results with the chloride.

Purification of Materials.

Cobaltous Chloride.—The simplest method of freeing cobaltous salts from the salts of other metals was previously found to be precipitation of purpureo-cobalt chloride. This substance is only slightly soluble in cold hydrochloric acid solutions, but readily soluble in hot ammonia. It was prepared by bubbling air for several days through an ammoniacal solution of commercial cobalt chloride, and then adding hydrochloric acid in excess. The purpureo-chloride thus precipitated was collected and the mother-liquor removed as completely as possible by filtration upon a large porcelain Gooch crucible. It was then dissolved in hot re-distilled ammonia, and the solution was filtered into a concentrated, distilled hydrochloric acid solution. The product, after washing with hydrochloric acid, was collected upon a Gooch crucible as before.

The final purification consisted in re-crystallising the amine three times by solution in the purest re-distilled ammonia in a platinum dish, and filtration with a platinum funnel into a quartz dish containing hydrochloric acid which had been distilled with a quartz condenser. Care was taken always to have an excess of acid in the quartz dish, while the acid solution was never allowed to come in contact with platinum since it probably contained free chlorine. The product of the third precipitation was dried on a steam-bath, and was then converted into cobaltous and ammonium chlorides by heating to about 200° in a quartz crucible in an air-bath. For the latter purpose platinum proved to be unsuited, since it was slightly attacked during the decomposition of the amine, while the quartz crucible remained unchanged in weight. A temperature high enough to fuse the amine was very carefully

* From the *Journal of the American Chemical Society*, xxviii., No. 11

avoided. The ammonium chloride still contained by the cobaltous chloride was eliminated during the final heating of the salt in a current of hydrochloric acid gas. During this final heating also care was taken to increase the heat very gradually, so as to avoid fusion of the salt and consequent possible enclosure of ammonium chloride in masses of fused cobaltous chloride (*Zeit. Phys. Chem.*, 1903, xlvi., 194). Cobaltous chloride prepared in this way was designated Sample I.

For preparing the second sample of cobaltous chloride, cobaltamine, which had been at least once dissolved in ammonia and re-precipitated with hydrochloric acid, was heated on a steam-bath with an excess of sulphuric acid, until all chlorine and hydrochloric acid had been expelled. The cobaltous sulphate thus formed was then dissolved in water, the solution was filtered, and a large excess of ammonia was introduced. In order to free the cobalt from alkalis and silica this ammoniacal solution was then electrolysed in a platinum dish, a platinum wire serving as anode, and the dish as cathode. The deposit of cobalt was washed thoroughly with pure water, and dissolved in hydrochloric acid which had been freshly distilled through a quartz condenser. The solution was next evaporated to crystallisation, and the product was twice re-crystallised. In the third crystallisation the salt was drained with a centrifugal machine in which platinum Gooch crucibles served as baskets and platinum crucibles as receivers. Any trace of sulphate occluded by the electrolytic metal was effectually eliminated in this way, for the mother-liquors from the second re-crystallisations when tested for sulphates, always yielded negative results.

After superficial moisture had been eliminated in a desiccator over potassium hydroxide, the salt was powdered in an agate mortar, and heated in a platinum dish in an air-bath to expel the water of crystallisation. The first molecules of water are lost below 50°, and by keeping the temperature below this point it was possible to avoid melting the salt. It has been pointed out by Richards (*Zeit. Phys. Chem.*, 1903, xlvi., 194) that a salt dried in this way is left in the form of a skeleton which allows the escape of vapour from its inmost recesses, while if fusion takes place during drying, a portion of the original salt may be so enclosed within an impervious coating of anhydrous salt that escape of water is impossible. Except in Analyses 3 and 11 the remaining water of crystallisation was expelled during the final heating of the cobaltous chloride in a stream of dry nitrogen and hydrochloric acid gases. Here also the temperature was at first so low that melting of the salt was completely avoided. The temperature was raised to 400° only after apparently all the water was expelled. In Analyses 3 and 11 all the water was expelled in the air-bath.

Silver.—Pure silver was prepared in the fashion usually employed in this laboratory as follows:—To a dilute solution of silver nitrate an excess of hydrochloric acid was added. The silver chloride was shaken many times with pure water and was then reduced to metallic silver by means of a solution of sodium hydroxide and invert sugar. After the metal had been thoroughly washed with water, it was fused on charcoal with a blowpipe, and the lumps of silver were cleaned by scrubbing with sand and etching with nitric acid. Next they were dissolved in re-distilled nitric acid, the excess of nitric acid was neutralised with re-distilled ammonia, and the metal was precipitated with ammonium formate which had been made from re-distilled formic acid. After the silver had been washed with pure water until free from ammonia, it was again fused in a boat of pure lime before a blowpipe. The buttons of silver were then cleaned with nitric acid and washed with water. Finally the silver was deposited electrolytically, the buttons in turn serving as the anode, a piece of the purest silver as the cathode, and a concentrated solution of one of the buttons in nitric acid as the electrolyte. The electrolytic crystals were washed with water and ammonia, dried, and fused in a boat of pure lime in a porcelain tube in a current of electrolytic hydrogen. The ingots were then cut into pieces of convenient size by means of a jeweller's saw, and were subjected to prolonged cleansing with successive portions of dilute nitric acid, until the acid no longer gave a test for iron, traces of which on the surface of the buttons had been introduced from the saw. The pieces were further cleaned with ammonia and with water, dried in air, and then heated to 300° and cooled in a vacuum. They were preserved in a desiccator containing solid potassium hydroxide.

Method of Analysis.

The cobaltous chloride, contained in a platinum boat, was first heated in a current of hydrochloric acid gas in a hard glass tube. An apparatus consisting of a series of towers which supplied either pure dry hydrochloric acid gas, nitrogen, or air was constructed wholly of glass by Dr. M. A. Hines for work upon the atomic weight of cadmium (Baxter and Hines, *Journ. Am. Chem. Soc.*, 1905, xxvii., 222; Baxter, Hines, and Frevert, *Ibid.*, 1906, xxviii., 770) and manganese (Baxter and Hines, *Ibid.*, 1906, xxviii., 1560), and was kindly loaned for this investigation. The hydrochloric acid gas was generated by dropping concentrated sulphuric acid into concentrated hydrochloric acid, and was dried by passing through five towers filled with beads moistened with concentrated sulphuric acid. Nitrogen was produced by passing a mixture of air with an excess of ammonia over heated rolls of copper gauze. It was freed from ammonia and further purified by passing through three wash-bottles containing dilute sulphuric acid, a tower filled with beads moistened with a solution of silver nitrate to remove sulphur compounds taken from rubber connections at the beginning of the apparatus, a tower filled with solid potassium hydroxide, then through three towers filled with beads moistened with concentrated sulphuric acid, and finally through a tube containing re-sublimed phosphorus pentoxide. The air was purified by passing through a tower filled with solid potassium hydroxide, then through four towers filled with beads moistened with concentrated sulphuric acid, and finally through a tube containiug phosphorus pentoxide.

In preliminary experiments in which cobaltous chloride was fused in an atmosphere of pure hydrochloric acid gas, the platinum boat containing the salt was always seriously alloyed on the surface with metallic cobalt. This phenomenon was probably due to partial dissociation of the cobaltous chloride vapour which was invariably formed in considerable quantities when the salt was heated barely to fusion. It was possible to reach a temperature of 400° without meeting the above difficulty, consequently this temperature was employed in the preparation of all samples for analysis, although the salt was not fused at this temperature.

The salt was heated very gently at first in a current of hydrochloric acid gas containing a small quantity of nitrogen until the greater part of the ammonium chloride or water had been expelled, without melting the salt. Then the temperature was increased until finally the salt was maintained at about 400° for at least an hour, usually much longer. After the heating had ceased, the mixture of nitrogen and hydrochloric acid was displaced by nitrogen, and this in turn by dry air, and the boat was transferred to a weighing-bottle without exposure to moist air by means of the bottling apparatus which has frequently served for a similar purpose in many atomic weight investigations in this laboratory (Richards and Parker, *Proc. Am. Acad.*, 1896, xxxii., 59).

The weighing-bottle containing the boat and salt was weighed, after it had stood in a desiccator beside the balance case for some time. Then the boat was transferred to a flask containing about 250 cc. of pure water, and the weighing-bottle was rinsed with water, the rinsings being added to the solution in the flask. A trace of insoluble matter was collected by filtering the solution through a tiny filter into a glass-stoppered precipitating flask, and the filter was ignited in a weighed platinum crucible. This residue, which consisted chiefly of cobalt oxide, never

amounted to as much as two-tenths of a mgrm. In Analyses 1, 2, 9, and 10 a slight increase in the weight of the boat was caused by incipient dissociation of the salt and alloying of the boat. The increase was only 0·05 mgrm. in the case of Analyses 1 and 9, 0·66 mgrm. in the case of Analyses 2 and 10. In these cases the weight of the boat after solution of the cobaltous chloride in water, washing and drying at 100° was determined and used in the calculations. These two analyses yielded results essentially identical with the remainder.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, January 17th, 1907.

Prof. R. MELDOLA, F.R.S., President, in the Chair.

(Concluded from p. 69).

14. "*The Condensation Products of Triacetic Lactone with Aceto-acetic Ester and β-Aminocrotonic Ester.*" By FREDERICK NOEL ASHCROFT FLEISCHMANN.

Triacetic lactone condenses in presence of strong sulphuric acid and hydrochloric acid, &c., with aceto-acetic ester, to form a *pyrone-lactone*, $C_{10}H_8O_4$, melting at 214°. The substance is extremely stable towards acids, but unstable in presence of alkalis, with which it forms deep yellow solutions. It yields a stable *bromo*-compound (m. p. 190°) crystallising from benzene with benzene of crystallisation, and a *nitro*-derivative (m. p. 200° approx.) which on treatment with strong aqueous ammonia yields aminodehydracetic acid. An unstable abnormal *barium* salt was also prepared, from which an insoluble, unstable *silver* and a *mercuric* salt were obtained.

A similar condensation takes place between triacetic lactone and β-aminocrotonic ester in presence of sulphuric, hydrochloric, or glacial acetic acids. The same pyrone-lactone is produced and, in the last instance, a second compound corresponding to the formula $C_{16}H_{19}O_6N$, the constitution of which is proved by its yielding the ethyl ester of ψ-lutidostyrilcarboxylic acid on treatment with alcoholic potash.

15. "*Derivatives of Multivalent Iodine.* Part II. *Action of Heat on* p-*Iodoacetophenone Dichloride,* p-*Iodoacetanilide Dichloride, and on the Dichlorides derived from* o-, m-, *and* p-*Iodotoluene.*" By WILLIAM CALDWELL and EMIL ALPHONSE WERNER.

One of us (Werner, *Trans.*, 1906, lxxxix., 1632) has shown that *p*-iodoacetophenone dichloride and *p*-iodoacetanilide dichloride when heated decompose with probable formation of substitution derivatives, thus differing from the general decomposition which has been hitherto recognised in connection with the chlorides derived from tervalent iodine.

When *p*-iodoacetophenone dichloride, $CH_3{\cdot}CO{\cdot}C_6H_4{\cdot}ICl_2$, is heated (Werner, *Trans.*, 1906, lxxxix., 1632) it decomposes suddenly at 93—94°, only traces of chlorine (0·43 per cent) being evolved in the free state, and *chloro*-p-*iodoacetophenone* is produced to the extent of 98 per cent of the theoretical, thus:—

$$CH_3{\cdot}CO{\cdot}C_6H_4{\cdot}ICl_2 = CH_2Cl{\cdot}CO{\cdot}C_6H_4I + HCl.$$

It forms long, slender prisms (m. p. 126—127°), and on oxidation it furnishes *p*-iodobenzoic acid. With chlorine it yields $CH_2Cl{\cdot}CO{\cdot}C_6H_4{\cdot}ICl_2$, which decomposes at 128—130° with production of *dichloro*-p-*iodoacetophenone*, $CHCl_2{\cdot}CO{\cdot}C_6H_4I$ (m. p. 62—63°). This also gives *p*-iodobenzoic acid on oxidation, and unites with chlorine to form $CHCl_2{\cdot}CO{\cdot}C_6H_4{\cdot}ICl_2$, which is decomposed by heat with evolution of most of the chlorine in the free state.

p-Iodoacetanilide dichloride, $CH_3{\cdot}CO{\cdot}NH{\cdot}C_6H_4{\cdot}ICl_2$, decomposes at 105°, and yields *chloro*-p-*iodoacetanilide*, $CH_3CO{\cdot}NH{\cdot}C_6H_3ClI$ (m. p. 144°), from which a *chloro-iodoaniline*, $C_6H_3ClI{\cdot}NH_2$ ($NH_2:I:Cl = 1:4:2$ or 3) (m. p. 73°), is obtained. The *picrate* melts at 132°.

Chloro-*p*-iodoacetanilide unites with chlorine, forming $CH_3CO{\cdot}NH{\cdot}C_6H_3Cl{\cdot}ICl_2$, which decomposes at 131°, and yields a substitution product which has not yet been investigated.

The action of heat on the chlorides of *o*-, *m*-, and *p*-iodotoluenes, prepared by Willgerodt, has been examined.

o-Tolyliodochloride decomposes at 85—86°, and yields *o*-iodobenzyl chloride, $C_6H_4I{\cdot}CH_2Cl$, which gives *o*-iodobenzoic acid on oxidation.

m-Tolyliodochloride decomposes at 88°, giving an iodochloride which yields on oxidation an acid melting at 210°, and containing both chlorine and iodine.

p-Tolyliodochloride decomposes at 110°, giving *p*-iodobenzyl chloride. In each case a small proportion of the original iodotoluene is regenerated.

16. "*Disalicylamide.*" By JAMES MCCONNAN.

o-Salicylsalicylamide does not possess the properties previously attributed to it (*Patentschrift*, No. 111, 656); the compound thus named by Cohn was probably disalicylamide.

Under suitable conditions, *o*-salicylsalicylamide rearranges, forming disalicylamide, and *vice versâ*; this is another case of the metoxazone tautomerism peculiar to acyl derivatives of salicylamide, and already studied in the cases of the benzoyl and the acetyl derivatives (McConnan and Titherley, *Trans.*, 1906, lxxxix., 1318).

17. "*Benzoyl Derivatives of* N-*Methylsalicylamide.*" By JAMES MCCONNAN and MORRIS EDGAR MARPLES.

N-*N*-Dimethylsalicylamide is a stable substance; *N*-methyl-*N*-benzoylsalicylamide, however, is unstable, and under the conditions of its formation it is either instantly hydrolysed or rearranges, forming *N*-methyl-*O*-benzoylsalicylamide. It thus appears that, although derivatives of the general formula $C_6H_4{<}^{CO{\cdot}N{\cdot}R_2}_{OH}$ are stable, substances of the type $C_6H_4{<}^{CO{\cdot}N{\cdot}R{\cdot}Ac}_{OH}$ are too unstable to permit of isolation. This result is of considerable interest, since McConnan and Titherley have already shown (*Trans.*, 1906, lxxxix., 1327) that *N*-*N*-diacylsalicylamides, $OH{\cdot}C_6H_4{\cdot}CO{\cdot}N{<}^{R}_{R}$, are too unstable to exist.

18. "*The Velocity of Reaction of Bromine with some Unsaturated Acids in Aqueous Solution.*" By ERNEST BARRETT and ARTHUR LAPWORTH.

Recent communications from W. Herz and B. Mylius (*Ber.*, 1906, xxxix., 3816) and from J. J. Sudborough and J. Thomas (*Proc.*, 1906, xxii., 318) deal with the addition of bromide to cinnamic acid and its esters in organic solvents. We have been engaged in the examination of addition of bromine to some unsaturated acids in aqueous solutions in the hope of throwing some light on the mechanism of such reactions.

The changes are somewhat difficult to follow, as the velocities are very considerable, and even in dilute solutions the time must be measured in seconds instead of hours. The temperature employed was 14·9° in the first three cases and 25·5° with the monobromocinnamic acids, and the experiments were carried out in artificial light.

Cinnamic Acid.—With equimolecular proportions of acid and halogen in N/1000 solutions, nearly the whole of the bromine disappeared in thirty seconds. With excess of bromine, 1·5 mols. were absorbed in about eighty minutes, this effect being due to the formation of bromocinnamic acids from the initial product. With crotonic acid and bromine, in equimolecular proportions in N/200 solutions, more than nine-tenths of the bromine was used in forty-five seconds.

Benzylidenemalonic Acid.—With N/200 solutions, about 0·5 mol. of bromine was absorbed in one minute, and the change had during the greater part of its course the form of a termolecular reaction. With the sodium salt the velocity is much greater, nine-tenths of the bromine disappearing in about thirty seconds. In N/2 sulphuric acid the velocity was about one-tenth of its usual value. Potassium bromide also lowers the reaction velocity, but not so decidedly; thus in N/2 potassium bromide the velocity was about three-fifths of its ordinary value.

The reaction, towards its end, is complicated, the product losing hydrogen bromide and carbon dioxide, the resulting bromocinnamic acid accounting for some of the bromine. Thus with excess of bromine, 1½ mols. of halogen disappeared in twenty minutes.

β-Monobromocinnamic Acid.—With equimolecular proportions of acid and bromine in N/100 solutions, about 0·25 mol. of bromine disappeared during the first half-minute. The change, in presence of excess of hydrogen chloride or potassium chloride, is of the bimolecular form; in absence of these agents the decomposition of the initial addition product occurs with measurable speed. The sodium salt is brominated at about the same rate as the free acid at first, but later the secondary reactions are more evident. Hydrogen chloride or potassium bromide diminish the reaction velocity, but apparently never to more than half the normal value. In this case, mineral acids have considerably less effect than have bromides, an observation consistent with the fact that the sodium salt and the acid have nearly the same velocity of bromination. The sodium salt of the stereoisomeric *α-monobromocinnamic acid*, it is interesting to note, absorbs bromine many times more rapidly than does the free acid.

The results appear inconsistent with the view that bromine dissociates into ions before addition at a double linking. They seem to show, however, that the ions of the acids, as well as the acids themselves, unite with bromine directly.

19. "*Note on the Molecular Complexity of Liquids.*" By ALBERT ERNEST DUNSTAN and FERDINAND BERNARD THOLE.

In a recent paper (*Trans.*, 1906, lxxxix., 1774) Holmes deals with the question of molecular complexity from the point of view of the volume changes produced on mixing. By calculating the greatest difference between the volume of alcohol actually present and the volume which would be present assuming no contraction, he assumes, for mixtures of alcohol and water, for example, that this maximum ($1C_2H_5\cdot OH, 1H_2O$) implies approximation of the ratio of the radii of "influential spheres" to unity.

The following table shows that the ratio does not approximate to unity, taking as a basis of calculation the true molecular volumes given by the author:

	Mol. vol.	Max. diff. of alcohol percentages by vol. at:		Above ratio of radii
Ethyl alcohol ..	3·22	$C_2H_5\cdot OH, 1\frac{1}{2}H_2O$	$\sqrt[3]{\frac{3\cdot22}{1}}$	= 1·47
n-Propyl alcohol	4·07	$C_3H_7\cdot OH, 1\frac{1}{2}H_2O$	$\sqrt[3]{\frac{4\cdot07}{1}}$	= 1·60
Propionic acid..	4·06	$C_2H_5\cdot CO_2H, 1H_2O$	$\sqrt[3]{\frac{4\cdot06}{1}}$	1·59
n-Butyric acid ..	5·08	$C_3H_7\cdot CO_2H, 1H_2O$	$\sqrt[3]{\frac{5\cdot08}{1}}$	= 1·72

Throughout the paper the author refers to the one constituent of a mixture as possessing the more active molecule usually of greater molecular volume and carrying a preponderating effect into the mixture. It would be more correct to look upon solution from the point of view of the reciprocal effect of the one component on the other; when this is done, for example, in the case of alcohol and water, the maximum effects are to be noticed at the proportions $1C_2H_5\cdot OH, 3H_2O$ (Dunstan, *Trans.*, 1904, lxxxv., 823).

Holmes regards the lower alcohols and acids of the paraffin series, from similar considerations, as having the same complexity as water; water he assumes to have the aggregate formula $(H_2O)_2$. Now there is a considerable amount of evidence available which shows that the earlier liquids of homologous series tend to associate somewhat particularly those the members of which are hodroxylated.

It has been shown that the quantity $\frac{\text{Viscosity}}{\text{Mol. vol.}} \times 10^6$ is nearly constant, viz.: 60 for such liquids as are currently accepted as unimolecular, but for the hydroxylated associated class the values are much in excess of 60 (Dunstan, *Zeit. Physikal. Chem.*, 1905, li., 732):

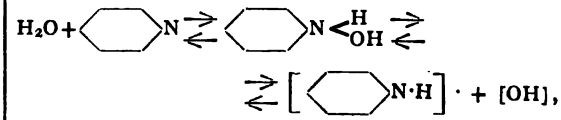
Benzene	65
Chloroform	67
Carbon disulphide	60
Water	493
Methyl alcohol	138
Ethyl alcohol	189
Acetic acid	195
Glycerol	106,000

Again, when viscosity coefficients are plotted against molecular weights, not only do the alcohols and acids relatively stand apart from the unimolecular liquids, but also the curves show such divergences at the beginnings of the series as to justify the idea of increased association.

Glycerol and nicotine are the only unimolecular liquids quoted in the table (p. 1785); now glycerol is not only notably viscous, but also has a remarkably high temperature coefficient of viscosity; both these facts indicate its association.

Carbon disulphide (*loc. cit.*) is mentioned as possessing four times the complexity of alcohol and is therefore represented by the formula $[CS_2]_8$; it is inconceivable from such data as, for example, its low boiling point, its low viscosity coefficient, the variation of its molecular surface energy with temperature, and its position in the molecular weight-viscosity chart.

Pyridine is quoted as a liquid which has the same molecular complexity as water and the alcohols. If this is so it is extraordinary that the viscosity concentration curves of mixtures of pyridine with alcohol on the one hand and with water on the other should be so entirely different. From an investigation now in progress on pyridine solutions it is found that in aqueous solution a maximum occurs at the proportions $2C_5H_5N, 5H_2O$, and secondary irregularities at $3C_5H_5N, 2H_2O$, $2C_5H_5N, 7H_2O$, $1C_5H_5N, 5H_2O$, and $1C_5H_5N, 10H_2O$. These discontinuities can only be explained by the assumption of loosely held complexes in dynamic equilibrium, which ionise to a considerable extent, and which generally behave like ammonium hydroxide,



but in alcoholic solution no maximum point is noted; the curve is composed of two branches which represent (1) the viscosity curve of associated alcohol with dissociated pyridine, and (2) dissociated alcohol with associated pyridine.

A precisely similar curve is afforded by alcohol-benzene mixtures. A study of the viscosity curves (Dunstan, *Trans.*, 1905, lxxxvii., 11, and *loc. cit.*) enables the changes in association which take place to be followed qualitatively, whilst the curves connecting molecular weight with viscosity coefficient give a quantitative idea as to the degree of association existing in any given liquid

Anniversary Dinner.

It has been decided by the Council to arrange for a Dinner of the Fellows of the Society and their friends on Friday, March 22nd, 1907, this being the day fixed for the Annual General Meeting. Further particulars will be announced shortly.

FARADAY SOCIETY.

Ordinary Meeting, January 29th, 1907.

Prof. H. E. ARMSTRONG, F.R.S., in the Chair.

Discussion on "Osmotic Pressure."

THE discussion was opened by the EARL of BERKELEY, who exhibited and described his Apparatus for the Direct Measurement of Osmotic Pressure.

The ordinary direct method of measuring osmotic pressures is to obtain equilibrium on the two sides of the semi-permeable membrane by means of the pressure of a head of liquid. The method devised by the author and Mr. E. G. J. Hartley substitutes mechanical pressure, which is put straight on the solution, and equilibrium thus obtained. Reversing the usual arrangement, the solution is put outside the semi-permeable tube, in an outer containing tube of gun-metal, and the solvent inside, suitable mechanical arrangements being provided for rendering the joints leak-tight. The pressure is obtained from a plunger worked with a pile of weights and delivered through a mercury U-tube to the solution outside the septum. Equilibrium is obtained or calculated by watching through a telescope the motion of the solution in a gauge. The measurements may be made at any desired temperature. Corrections are applied for the imperfect semi-permeability of the membrane by analysing the solvent to see if any solution has passed into it.

A vapour-pressure method for measuring osmotic pressure was also described. This is a modification of the Ostwald and Walker dynamical method. Air is sucked through a spiral train of glass vessels containing first sulphuric acid, to dry it, then the solution from which it gets saturated up to the vapour pressure of the latter, then the solvent, of which it here takes up more, and finally sulphuric acid again. There are two trains of vessels arranged to oscillate about a central axis, so that the air does not actually bubble *through* the liquids, which is unsatisfactory, but merely passes *over* them, glass beads being placed in the tubes to increase the melting surfaces. The whole apparatus can be placed in a bath and worked at any desired temperature. Arrhenius's relation was used for calculating the osmotic pressures from the lowered vapour pressures, and very concordant results were shown to have been obtained between measurements made by the direct-pressure and the vapour-pressure methods. The author is of opinion that the latter method will chiefly have to be relied upon to furnish accurate data for the further study of osmotics.

Mr. W. C. DAMPIER WHETHAM, F.R.S., speaking on "Indirect Methods of Measuring Osmotic Pressure," agreed as to the importance of the vapour-pressure method. He discussed the formula used by Berkeley and Hartley, and explained the difference between it and and the van't Hoff formula obtained from thermodynamic considerations, the expressions being identical where there is no change of volume of the solvent as it enters the solution.

Dr. T. M. LOWRY spoke on "Osmotic Pressure from the Standpoint of the Kinetic Theory." The motion of the particles postulated by the kinetic theory leads in the case of composite gases or liquids to a process of diffusion. When diffusion is resisted a pressure is set up which constitutes the osmotic pressure of the system. This can be effected by means of a semi-permeable membrane, through which only one of the constituents can pass. Such membranes undoubtedly act in virtue of their solvent properties.

The application of the equation $PV = RT$ to the osmotic pressure of gases could be predicted on general theoretical grounds, but there was no *à priori* reason for supposing that it would be applicable to the case of liquids. The mere fact that all liquids were not miscible was sufficient to show that the conditions were widely different from those prevailing in mixed gases. The validity of the law had been established experimentally, and must be accepted as a fact of fundamental importance in all discussions as to the nature of osmotic pressure.

In the early years of the osmotic discussion it had been assumed by van't Hoff and others that since osmotic pressures and gas pressures could be calculated by means of the same formula the conditions must be identical in the two cases, and it was definitely stated that in dilute sugar solutions the osmotic pressure was wholly due to the bombardment of the membrane by the molecules of the sugar, the effects produced by the water molecules being substantially identical on either side of the membrane. The alternative view, that osmotic pressure represented a diminution in the activity or "active mass" of the solvent was suggested by Poynting in 1896, and had subsequently been advocated by Armstrong, Beilby, van Laar, and others. In most cases it had been assumed that the essential factor was a diminution in the average energy of the water molecules. From the standpoint of the kinetic theory this was unnecessary, as also was the view advocated by Rodger and by Traube that the solute was directly combined with one or more molecules of the solvent. The mere presence in the surface of the solution of molecules of the solute which could not enter the membrane was sufficient to check the escape of solvent particles from the solution into the membrane, without affecting the reverse passage of solvent from the membrane into the solution. This would lead to a diminished solubility on the side of the solution and to a flow of liquid through the membrane which could only be checked by putting pressure on the solution.

The simplest case of a semi-permeable membrane is undoubtedly to be found in the surface of separation between liquid and vapour. At such a surface the kinetic theory postulates a continual interchange of molecules between the two phases. But whilst the rate of escape or evaporation would be reduced by the presence of non-volatile molecules in the surface, the rate of condensation would be unaffected, and equilibrium could only be restored by decreasing the vapour pressure and so diminishing the rate of condensation at the surface of the solution. In this case a quantitative relationship could be deduced. If N and n were the relative numbers of particles of solvent and solute in the surface and p and p^1 the vapour pressures of solvent and solution, then if each molecule of solute replaced a single molecule of solvent in the surface layer, the reduction of vapour pressure would be shown by the equation—

$$\frac{p^1}{p} = \frac{N}{N+n}.$$

It had been shown by Nernst that from this simple relationship the identity of the osmotic pressure of a dilute solution with the pressure exerted by a gas of equal molecular concentration could be directly deduced. The blocking of the surface was, therefore, sufficient to afford, not merely a qualitative, but also a quantitative explanation of osmotic pressure.

The further discussion of the surface structure of liquids as related to the osmotic phenomena will be printed in the *Transactions*.

Professor L. KAHLENBERG sent in a communication to the discussion on "The Bearing of Actual Osmotic Experiments upon the Conception of the Nature of Solutions."

The occurrence of osmosis and its direction and extent are determined by the nature of the septum and of the

liquids that bathe it. Experiments have shown, too, that there is always a major and minor current present, following in opposite directions, although it often appears as if the osmotic process were one-sided. In this case the septum is termed "semi-permeable," and recent research has centred around so-called semi-permeable membranes which really do not exist. The author has demonstrated that it is peculiarly strong selective action on the part of the septum which causes it to be approximately semi-permeable in certain cases, and he has recently even succeeded in separating two colloidal substances by dialysis. This selective action is due to the solubility or insolubility of the substances concerned in the membrane, and therefore osmotic pressure is due to the same forces—essentially chemical in character in the opinion of the author—as the process of solution, and they may be quite variable as different septa and different liquids are employed. The usually accepted "sieve theory" is untenable, because larger molecules frequently go through a membrane more readily than smaller molecules.

So-called semi-permeable membranes have of late years been studied on account of their bearing on van't Hoff's "gaseous pressure" theory of solution and of osmotic pressure. This maintains that as long as the membrane is semi-permeable the osmotic pressure is the same in the case of any septum for a given solution against the pure solvent, a position contrary to experimental facts.

Again, by applying Carnot's cycle and the usual thermodynamic formulæ to the hypothetical case of abstracting, and then returning solvent from a dilute solution in a cylinder fitted with a semi-permeable piston, relations have been deduced between latent heats of fusion and freezing points, and latent heats of vaporisation and boiling points, assuming the gas equation to hold for dilute solutions. But the results obtained are frequently far from the experimental values found for different solutes in the case of one and the same solvent (in the case of electrolytes), and it has been necessary to postulate either dissociation or polymerisation; but the author referring to his previous papers, considers these explanations are weak and unnecessary. The thermodynamic calculations involve the assumption of a semi-permeable membrane which at the same time is quite passive. As it is selective action which produces semi-permeability, no such membrane can exist. Therefore, thermodynamic osmotic pressure (which is not really osmotic pressure at all) is quite a different thing from that measured by experiment. Finally, to speak of the experimental osmotic pressure of any solution, without mentioning what septum is used to separate that solution from what other liquid, is devoid of meaning.

Mr. H. N. MORSE communicated tables containing a summary of the recent experiments, the results of which are about to be published, made by him and Mr. Frazer, with glucose and cane-sugar. The conclusions arrived at are:—1. In the vicinity of 20° the osmotic pressure exerted by either is equal to that which a molecular equivalent quantity of a gas would exert if its volume were reduced, at the same temperature, to the volume of the solvent in the pure state. 2. Between 18° and 26°, at which the measurements were made, both cane-sugar and glucose in solution are in the anhydrous condition. Measurements made just above 0° yield pressures somewhat above the calculated gas pressures. Measurements with electrolytes are about to be made in which osmotic pressure and dissociation will be determined simultaneously.

Dr. J. C. PHILIP thought, with reference to Dr. Lowry's hypothesis, that whatever views might be entertained as to the nature of osmotic pressure, one was bound, on thermodynamic grounds, to conclude that dilute solutions must behave as a gas in relation to concentration and temperature.

Mr. J. G. A. RHODIN remarked on the fact that osmotic pressure as usually explained seemed to work in the wrong direction, namely, from the lower in the direction of the higher pressure. It was remarkable, too, that a semi-permeable membrane should conduct electricity so easily. Many of the supposed agreements between calculated and observed results and modern physical chemistry were due to a reckless and unjustifiable use of the method of least squares.

Dr. ALEXANDER FINDLAY said that on account of unfamiliarity with van't Hoff's theory of solutions there had been much misunderstanding as to what was the problem actually to be investigated. Referring to Kahlenberg's objection to semi-permeable membranes, from the thermodynamic standpoint it did not matter whether there were selective absorption or not, provided the changes in energy were equal in opposite directions. He considered that the quantitative side and the thermodynamic side of the subject had been thoroughly worked out, and the remarkable accuracy of the work of Morse and Frazer, and Berkeley and Hartley, pointed to absolute agreement between experiment and the van't Hoff thermodynamic theory. He did not take kindly to Dr. Lowry's kinetic explanation, and thought that the membrane might be left out altogether, and the diffusion only between a solution and a layer of pure solvent on the top of it made use of for explaining what took place.

Mr. W. A. DAVIS said that van't Hoff's original hypothesis neglected the influence exerted on the solute by the solvent; Dr. Lowry's modification of van't Hoff's conception was therefore necessary from that standpoint. Osmotic pressure had also been explained as the tendency to equalise the surface tension on the two sides of the osmotic cell.

The EARL OF BERKELEY disagreed with Dr. Findlay that the thermodynamic was the only logical way of looking at things. He discussed further the discrepancy between the formula used by him and the thermodynamic formula which could be explained on the conception one formed of osmotic pressure.

Dr. T. M. LOWRY said that the views he advocated accounted for the negative direction of the osmotic flow referred to by Mr. Rhodin. It was not remarkable that Boyle's law should hold good for osmotic pressure, but it was remarkable that the constant R in the two cases should be identical. The agreement should throw light on the surface structure of liquids.

The CHAIRMAN emphasised the general applicability of the vapour-pressure method, which, although tedious and troublesome, could be used with any solvent, at all temperatures, and under all pressures. The compressibility of liquids would prevent it agreeing quite with direct measurements; it was therefore important that careful comparisons of the two should be made. In reply to Dr. Findlay, Morse and Frazer's results did not agree with those of Berkeley and Hartley; there was a possible constant error in the former, in spite of the extraordinary accuracy of the work. He hoped more experimental work would be done with living tissues on the line of Pfeffer's original measurements. The term "osmotic pressure," unless merely used in the sense of a pressure required to establish equilibrium, was a misleading one; there was nothing to show that a pressure existed inside a solution in a closed vessel apart from simple gravity pressure. The results of Morse and Frazer brought dilute and concentrated solutions into line, and were a great advance on the van't Hoff treatment; they put the ordinary gas point of view quite out of court. He deprecated the dogmatic, unscientific treatment to which the whole subject had been subjected for the purpose of bolstering up a particular point of view: the facts needed examination from a broad and critical standpoint.

NOTICES OF BOOKS.

Practical Sanitation. By GEORGE REID, M.D., D.P.H. Thirteenth Fdition. London: Charles Griffin and Co., Ltd. 1906.

A GREAT deal of useful information with which householders and the general public would do well to acquaint themselves, is contained in this handbook, which treats fully of such questions as the filtration of water for drinking purposes, the ventilation and warming of dwelling houses, schools, and other places, and infection and the most effectual ways of disinfecting. The primary object of the author was, however, to provide a handbook for the use of sanitary inspectors, and this aim he has admirably fulfilled. His advice and teaching are sound, and no branch of sanitation is passed over. An appendix by Dr. Herbert Manley on Sanitary Law gives a summary of the chief provisions of the various statutes affecting the duties of inspectors, a knowledge of which is now necessary for candidates for the certificates of the Sanitary Inspectors' Examination Board and of the Royal Sanitary Institute. The thirteenth edition has been published very soon after the appearance of the twelfth, in order that recent progress in sanitation may be described, and the appendix has been entirely re-written.

A Handbook of Physics and Chemistry. By HERBERT E. CORBIN, B.Sc. (Lond.), M.R.C.S., L.R.C.P., D.P.H., and ARCHIBALD M. STEWART, B.Sc. (Lond.), B.A. (T.C.D.). London: J. and A. Churchill. 1907.

THIS book contains a complete elementary course of physics, inorganic and organic chemistry, such as is indicated by the syllabus for the First Examination of the Royal Colleges and also those of the Pharmaceutical Society and the Royal Veterinary College, and candidates for these examinations will find it convenient to have all that they require in one text-book, written specially to meet their needs. The subjects are treated from a theoretical point of view, and while there is not much that is new in the book the explanations are always clear and concise. In the third edition chapters on light and sound have been added, and some of the section on inorganic chemistry has been enlarged.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No.4, January 28, 1907.

Cuprous Metaphosphate.—V. Auger.—On heating copper filings in a platinum crucible with phosphoric acid, no marked change in the metal takes place until the acid is converted into a mixture of pyro- and metaphosphoric acids. Hydrogen is evolved, and the acid turns brown with the formation of the cuprous salt, but this is at the same time oxidised by the air, and bluish white crystalline scales of cupric metaphosphate are formed. To avoid the action of the air and obtain the lower salt, metaphosphoric acid heated to a dull red is poured upon excess of copper filings in a covered platinum crucible; heating is continued for a time, and the dark mass is then rapidly decanted into another platinum crucible, which is immediately covered. Analysis shows that the cuprous phosphate, stable at a red heat, on cooling decomposes into cupric metaphosphate and metallic copper. Thus, $Cu_2(PO_3)_2 = Cu(PO_3)_2 + Cu$. It is possible to obtain the cuprous salt and keep it in the cold state for several days, if the hot solution is allowed to fall, a drop at a time, into methyl chloride. Perfectly transparent little glassy masses are thus obtained of a pale yellow colour, composed of cuprous metaphosphate in solution in metaphosphoric acid. They can be preserved for several days in a sealed tube, but a slow molecular change takes place, and the transparency gives place to an opaque red-brown appearance, due to deposition of metallic copper. This decomposition of the cuprous salt into the cupric salt and the free metal is observable with a variety of acids. In spite of their instability, the cuprous salts of organic acids have, under certain conditions, been obtained and analysed.

Solubility of Carbon in Barium Carbide and Strontium Carbide.—H. Morel Kahn.—The author has made quantitative investigations of the solubility of carbon in the carbides of barium and calcium similar to those he has previously made in the case of calcium carbide, under differing conditions, in the electric furnace. The carbides of strontium and barium are made under the same conditions as that of calcium, but they are produced at lower temperatures, and therefore the heating of the carbides in the charcoal crucible is made less intense by placing the latter in a larger crucible and filling the space between the two with lamp-black. The following results were obtained at a constant intensity of 550 to 600 ampères, under about 90 volts:—

	Time of heating.	Graphite. per cent.
	I. *Barium Carbide.*	
1.	6 minutes	1·25, 1·50
2.	7 ,,	2·25
3.	8 ,,	2·77
4.	9 ,,	3·30, 3·90
5.	10 ,,	4·20, 4·30
6.	11 ,,	5·40, 6·20
	II. *Strontium Carbide.*	
1.	6 minutes	1·30, 1·50
2.	7 ,,	2·10, 2·28
3.	8 ,,	2·75, 3·20
4.	9 ,,	4·45
5.	10 ,,	6·15, 6·25

Thus, the carbides of the alkaline earths appear to possess in common the property of dissolving carbon. It is not possible to increase indefinitely the proportion of carbon dissolved, and a temperature is soon reached beyond which no comparable results are obtained. Prolonged heating causes dissociation and vaporisation of the carbide.

Causes which Influence the Estimation of Fluorine in Mineral Waters.—P. Carles.—There has been much conflicting evidence from skilful chemists as to the presence or absence of fluorine in certain mineral waters, the explanation being, perhaps, that the presence of silica, often in considerable quantity, renders the research on the fluorine in the evaporated residue of the water uncertain. It is therefore a question of successful elimination of the silica, and whether the acid method or the alkaline method is preferable. From a mineral water said to contain no fluorine, positive results were obtained by treating with sodium bicarbonate and ammonium carbonate successively, filtering off the precipitate of silica, and adding potassium acetate, barium chloride, and hydrochloric acid to the filtrate. A precipitate containing fluorine was thus obtained. No fluorine being obtained when the evaporated mineral water residue is treated with acid probably means that the fluorine has been eliminated as hydrofluoric acid. The following conclusions were drawn from researches by the alkaline method:—1. Out of ninety-three specimens of natural mineral waters, the presence of fluorine is pretty general, since only four or five gave negative results. 2. The degree of alkalinity of the water appears to bear some relation to the weight of fluorine separated. 3. Calcium fluoride dissolves or precipitates in the water according to the quantity of carbonic acid gas present.

A New Method of Estimating the Halogens in Organic Compounds by Means of the Metal-ammoniums.—E. Chablay.—It has been found in studying the action of the metal-ammoniums upon different organic compounds containing halogens, that all the halogen corresponding to the quantity of matter employed is recovered always as the alkaline halogen salt. The author has made use of this property to obtain the estimation of these elements in bodies belonging to different series. *Principle of the Method.*—On treating with sod-ammonium or potassium-ammonium one molecule of any organic compound containing one or more atoms of a halogen, the latter is completely removed by the alkali metal of the ammonium, giving the corresponding halogen salt. This is easily estimated volumetrically by a silver nitrate solution. The results obtained from a great variety of experiments prove that this method is as accurate as the classical methods with calcium carbonate, or with the sealed tubes of Carius, the latter method involving well-known inconveniences. The method here described presents no difficulties, since the reactions are carried out in open tubes and at low temperatures; it is also more rapid, admitting of five or six estimations in a day; finally, it is of very general application, even for gaseous bodies such as methyl chloride.

Condensed Chromic Sulphates.—Albert Colson.—The researches of M. Recoura have shown that, on boiling, violet solutions of chromium sulphate turn green, owing to a condensation expressed as follows:—1. $2Cr_2(SO_4)_3 + H_2O = H_2SO_4 + Cr_2O(SO_4)_5$. The same reaction applies to chrome-alum and the normal green salts, as already announced by the author. The pentasulphate, $Cr_4O(SO_4)_5$, is found to exhibit the same property, but this is not easily identified, because boiling water is capable of reacting upon the pentasulphate, setting free a new quantity of acid:—2. $Cr_2O(SO_4)_5 + H_2O = Cr_4O_2(SO_4)_4 + H_2SO_4$. *Interpretation of Results.*—According to the views of M. Mathias, there occurs an association of a number of sulphuric molecules twice as great in the green salt as in the violet salt, *i.e.*, two violet chromic molecules condense in one molecule of the green sulphate. The green sulphate may be written $\begin{matrix} SO_4=Cr-SO_4-Cr=SO_4 \\ | \quad\quad | \\ SO_4=Cr-SO_4-Cr=SO_4 \end{matrix}$. As the divalent radical, SO_4, changes under the action of water into two monovalent radicals, HSO_4 and OH, the above representation indicates the existence of a classs of dichromic salts, of which the author believer othcr types exist in the concentration of the normal green salts.

Some Derivatives of Hordenine.—E. Léger.—In consequence of the fact that hordenine possesses the functions of both a tertiary amine and a phenol, it is able to give derivatives of both these classes. Derivatives of the amine function may be salts or alcohol derivatives. Those of the phenol function may be ether-salts or ether-oxides. The following derivatives are described:—I. *Derivatives of the Amine Function.*—The neutral tartrate of hordenine, $(C_{10}H_{15}NO)_2,C_4H_6O_5$; the acid tartrate, $C_{10}H_{15}NO,C_4H_6O_5$; chloromethylate of hordenine, $C_{10}H_{15}NO,CH_3Cl$; chloroethylate, $C_{10}H_{15}NO,C_2H_5Cl$; bromoethylate, $C_{10}H_{15}NO,C_2H_5Br$; iodoethylate, $C_{10}H_{15}NO,C_2H_5I$. II. *Derivatives of the Phenol Function*, obtained by the action of the corresponding acid chlorides upon hordenine, in solution in pyridine, in the case of the ether-salts. The chlorhydrate of benzoylhordenine, $C_{10}H_{14}(C_7H_5O)NO,HCl$; the bromhydrate,—

$$C_{10}H_{14}(C_7H_5O)NO,HBr;$$

the cinnamylhordenine; the chlorhydrate of cinnamylhordenine, $C_{10}H_{14}(C_9H_7O)NO,HCl + H_2O$; the chlorhydrate of anisylhordenine, $C_{10}H_{14}(C_8H_7O_2)NO,HCl + H_2O$. III. *Derivatives of Both Functions.*—1. Sulphomethylate of hordenine,—

$$C_{10}H_{15}NO + NaI = C_{10}H_{15}N\begin{matrix}CH_3 \\ SO_4CH_3\end{matrix}O + SO_4CH_3Na.$$

$$C_{10}H_{15}N\begin{matrix}CH_3 \\ I\end{matrix}O$$

2. Iodomethylate of methylhordenine, produced according to the above equation, may be written—

$$C_6H_4\begin{matrix}CH_2-CH_2-N\begin{matrix}CH_3 \\ I\end{matrix}-(CH_3)_2. \\ OCH_5\end{matrix}$$

Acetyl Nitrate.—Amé Piclet and Eugène Khotinsky.—The authors have obtained the new compound acetyl nitrate, $CH_3-COO-NO_2$, by dissolving in the cold nitric anhydride in acetic anhydride,—

$$\begin{matrix}CH_3-CO \\ CH_3-CO\end{matrix}>O + \begin{matrix}NO_2 \\ NO_2\end{matrix}>O = 2CH_3-CO-O-NO_2.$$

This can only be separated from the active anhydride by fractionating under reduced pressure. It passes over at 22° under a pressure of 70 mm.; it is a colourless liquid, very mobile, very hygroscopic, giving off copious vapours in air, which explode with violence when rapidly heated. The latter property prevented analysis by combustion, and an indirect method was resorted to for determination of the composition, the body being dissolved in water, the total acids determined by titration, and the nitric acid by Kjeldahl's method. Acetyl nitrate reacts with alcohols to give their acetic ethers or their nitric ethers, according to the nature of the alcohol and the temperature. With the aromatic compounds, it has a strongly nitrating action, its activity being due to the fact that the reaction occurs without elimination of water,—

$$R-H + NO_2-O-COCH_3 = R-NO_2 + CH_3COOH.$$

It reacts thus with benzene, toluene, anthracene, thiophene below 0°.

MEETINGS FOR THE WEEK.

TUESDAY, 19th.—Royal Institution, 3. "The Visual Apparatus of Man and Animals," by Prof. William Stirling.
—— Faraday Society. 8. "Present Position and Future Prospects of the Electrolytic Alkali and Bleach Industry," by J. B. C. Kershaw.

WEDNESDAY, 20th.—Society of Arts, 8. "Cold Storage and Food Supply," by Hal Williams.
—— Microscopical, 8. "An Early Criticism of the Abbe Theory," by J. W. Gordon. "Some Tardigrada of the Sikkim Himalaya," by J. Murray. "Some Rhizopods from the Sikkim Himalaya," by Dr. E. Penard. An Exhibition of Slides of Marine Zoological Objects lent by Mr. Flatters.

THURSDAY, 21st.—Royal Institution, 3. "The Minute Structure of Igneous Rocks and their Significance," by Mr. A. Harker.
—— Chemical. 8.30. "Constitution of Oxyazo Compounds," by W. B. Tuck. "Influence of Solvents on the Rotation of Optically Active Compounds—Part IX. A New General Method for Studying Intramolecular Change," by T. S. Patterson and A. McMillan. "The Reduction Products of Ortho and Para-Dimethoxybenzoin," by J. C. Irvine and A. M. Moodie. "Replacement of Halogens by Hydroxyl—I. The Hydrolytic Decomposition of Hydrogen and Sodium Monochloroacetates by Water and by Alkali, and the Influence of Neutral Salts on the Reaction Velocities," by G. Senter. "The Reaction of Ammonium Salts with the Constituents of the Soil," by A. D. Hall and C. T. Gimingham.

FRIDAY, 22nd.—Royal Institution, 9. "Flame in Gas and Petrol Motors," by Dugald Clerk.
—— Physical, 5. "Transformer Indicator Diagrams," by Prof. Lyle. "Ionisation of Gases by α-Particles of Radium," by Prof. Bragg. "A Micromanometer," by B. Roberts.

SATURDAY, 23rd.—Royal Institution, 3. "Röntgen, Cathode, and Positive Rays," by Prof. J. J. Thomson.

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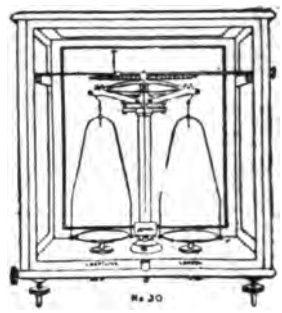

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THE CHEMICAL NEWS.

VOL. XCV., No. 2465.

THE TECHNICAL ESTIMATION OF ANTIMONY AND ARSENIC IN ORES, &c.

By A. H. LOW.

THE technical estimation of antimony in ores containing also arsenic and possibly tin is frequently a tedious and more or less unsatisfactory operation. Distillation methods may give correct results, but considerable experience in their manipulation is usually required, and perhaps, also, special apparatus not always at the disposal of the technical chemist having only an occasional antimony determination to make. The following method for both antimony and arsenic is free from these objections, and, in my laboratory, has given results closely checking those obtained by distillation. While it is largely based upon old ideas there are some points of novelty that tend to expedite the work, and the method as a whole is different from any I have seen published. The time required for determining both antimony and arsenic in an ore need not exceed two and one-half hours.

Take 1 grm. of the ore in a 150 cc. flask, add 7 grms. of potassium acid sulphate, 0·5 grm. of tartaric acid, and 10 cc. of strong sulphuric acid. Heat over a free flame (manipulating the flask in a holder), cautiously at first, finally with the full power of a Bunsen burner, until any free sulphur is entirely expelled and the separated carbon is completely oxidised, leaving a clean mass or melt with but little free sulphuric acid. Allow to cool with the flask on its side, as otherwise the solidifying cake may break it, or, spread the melt around on the sides while cooling. The object of the tartaric acid in the decomposition is to reduce the arsenic and antimony to the *ous* condition, thus rendering the subsequent solution of the antimony easy and the precipitation of both metals as sulphides rapid and complete. A covered casserole may be employed instead of a flask, if considered more convenient.

After cooling, add 50 cc. of water, 10 cc. of strong hydrochloric acid, and 2 or 3 grms. of tartaric acid. Heat nearly to boiling for a short time to dissolve everything soluble (especially anhydrous iron sulphate), but do not actually boil for fear of volatilising some arsenic. Filter, washing with hot water. This filtration is advisable but not a necessity. Dilute the filtrate to about 300 cc. with hot water, maintain the liquid warm, and pass in hydrogen sulphide. The arsenic and antimony being in the *ous* condition are quickly precipitated, ten minutes being usually sufficient. Filter, washing with hydrogen sulphide water. Rinse the sulphides into a beaker with hot water, using as little as will suffice, add a little colourless potassium sulphide and warm to extract the arsenic and antimony sulphides (also tin sulphide, if present). (If sodium sulphide is used a separation of sodium chloride crystals, occluding a little antimony, may occur later). Pour through the last filter and wash with warm water containing a little colourless potassium sulphide. With small amounts of other sulphides present one extraction will usually suffice. Receive the filtrate in a 300 cc. flask. Add to it about 3 grms. of potassium acid sulphate and 10 cc. of strong sulphuric acid and boil the mixture, finally over a free flame, until the free sulphur is all expelled and the greater part of the free acid also. Allow the clear melt to cool with the flask on its side. When sufficiently cool add 25 cc. of water and 10 cc. of strong hydrochloric acid and warm to effect complete solution, then cool nearly to room temperature under the tap. Now add 40 cc. of strong hydrochloric acid and pass in hydrogen sulphide. The arsenic will be quickly precipitated, being in the *ous* condition. Filter, washing flask and precipitate with a mixture of 2 volumes strong hydrochloric acid and 1 volume of water. Before filtering, moisten the filter with the acid mixture. A double filter supported by a platinum cone will not break under very gentle suction.

The arsenic is now all on the filter and the antimony (together with any tin) in the filtrate. Determine the two metals as follows:—

Antimony.—Dilute the filtrate with double its volume of warm water and pass in hydrogen sulphide. Filter the antimony sulphide and wash with hydrogen sulphide water sufficiently to remove most of the hydrochloric acid. Rinse the sulphide from the filter into a beaker, add a little ammonium sulphide, and warm to effect solution. Pour through the last filter, and wash with water containing a little ammonium sulphide. Receive the filtrate in a 300 cc. flask. Small amounts of antimony sulphide may be dissolved directly on the filter. To the filtrate add about 3 to 4 grms. of (pure) potassium acid sulphate and 10 cc. of strong sulphuric acid. Boil as previously described to expel, first the water, then all the free sulphur and finally most of the free acid. Cool, add 50 cc. of water and 10 cc. of strong hydrochloric acid. Heat to effect solution and then boil for a few minutes to expel any possible sulphur dioxide. Finally, add 10 cc. more of strong hydrochloric acid, cool under the tap, dilute to about 200 cc. with cold water, and titrate with a standard solution of potassium permanganate. The solution ordinarily used for iron titrations will answer. Tin, if present, exists as stannic sulphate and is without influence. The oxalic acid value of the permanganate multiplied by 0·9532 will give the antimony value.

Arsenic.—Thoroughly wash out the hydrochloric acid from the sulphide with hydrogen sulphide water, also rinsing out any sulphide remaining in the flask. Dissolve the sulphide (this may usually be done on the filter) in warm ammonium sulphide solution, and wash with the same solution diluted. Receive the filtrate in a 300 cc. flask. Add 2 to 3 grms. of potassium acid sulphate and 5 cc. of strong sulphuric acid. Evaporate, boiling to a small bulk, and then manipulate the flask over a free flame until the sulphur is entirely expelled and most of the free acid also. Take up, after cooling, by warming with 50 cc. of water and then boil sufficiently to expel any possible sulphur dioxide. Now drop in a bit of litmus paper as an indicator and then add ammonia until the solution is slightly alkaline. Again acidify slightly with hydrochloric acid and cool to room temperature. Finally add 3 to 4 grms. of sodium acid carbonate and a little starch liquor and titrate with standard iodine solution. Pay no attention to a slight discoloration toward the end, but proceed slowly until a single drop of the iodine produces a strong permanent blue colour.

The iodine solution may be prepared by dissolving about 11 grms. of iodine in a little water with the addition of about 20 grms. of potassium iodide and diluting to 1 litre. Standardise with arsenious oxide. Dissolve about 0·150 grm. in 5 cc. of strong hydrochloric acid by warming very gently, dilute and neutralise as described above, and finally titrate with the iodine solution. One cc. of the latter will equal about 0·003 grm. of arsenic.

It is perhaps unnecessary to enumerate a long list of instances showing the accuracy of the above method, and I will therefore mention only the following:—

	Taken. Grm.	Found. Grm.
As	0·0792	0·0798
Sb	0·0534	0·0531
Sb	0·0516	0·0514
Sb	0·0521	0·0525

With an oxidised ore: As, 0·568 per cent; Sb 0·106 per cent. Repeat; Sb, 0·106 per cent.

On this ore Pearce's method (modified) gave As 0·57 per cent.

The same ore gave, by Knorr's distillation method, Sb 0·082 per cent.

Ledoux and Co., of New York, reported Sb 0·081 per cent.

Mr. R. L. Wilder, of El Paso, tested this ore by the new method and found Sb 0·1005 and 0·0802 per cent. —*Journal of the American Chemical Society*, xxviii., No. 12.

A REVISION OF THE ATOMIC WEIGHT OF COBALT.*

FOURTH PAPER.—THE ANALYSIS OF COBALTOUS CHLORIDE.

By GREGORY PAUL BAXTER
and
FLETCHER BARKER COFFIN.

(Concluded from p. 78).

Method of Analysis (continued).

FROM the corrected weight of cobaltous chloride very nearly the requisite quantity of pure silver was calculated. This silver was weighed out, and dissolved in re-distilled nitric acid diluted with an equal volume of water in a small flask provided with a column of bulbs to prevent loss by spattering. After the solution had been diluted with an equal volume of water, the nitrous fumes were expelled by gentle heat. Then the solution of silver nitrate, after dilution until its concentration was about 1 per cent, was poured slowly, with constant agitation, into the solution of cobaltous chloride, which also had been diluted to a like concentration in the precipitating flask, and the flask was shaken for some time. The precipitation and subsequent filtration of the silver chloride were carried out in a cupboard made of ruby glass.

After the solution had stood for about two days with occasional agitation, and after the supernatant liquid had become perfectly clear, 25 cc. portions of the solution were tested with hundredth-normal solutions of silver nitrate and potassium chloride in a nephelometer (Richards and Wells, *Am. Chem. Journ.*, 1904, xxxi., 220) for excess of chloride or silver, and, if necessary, either standard silver nitrate or potassium chloride solution was added, and the process of shaking and testing repeated, until the amounts of silver and chloride were equivalent. The test solutions were always returned to the flask since they contained an appreciable amount of silver chloride, and the weight of silver chloride subsequently obtained was corrected for the quantity thus introduced.

As soon as the exact end-point had been found, about 1 decigrm. of silver nitrate in excess was added, in order to produce as complete precipitation of the silver chloride as possible, and the flask was again shaken and allowed to stand until clear. The precipitate of silver chloride was collected upon a Gooch crucible, after it had been washed several times with a dilute solution of silver nitrate, and finally ten times with pure water. Then it was heated in an electric oven for five hours at 180°, cooled in a desiccator, and weighed.

In order to determine the moisture still retained by the dried silver chloride, in each case it was transferred as completely as possible to a porcelain crucible, and weighed. Then the salt was fused by heating the small covered crucible contained in a large crucible, and again weighed.

Although the filtrate and silver nitrate wash-waters were nearly free from dissolved silver chloride, the aqueous washings contained appreciable quantities of this substance. The amount of dissolved salt in both filtrate and wash-waters was determined by comparison with standard chloride solutions in a nephelometer. It has recently been

* From the *Journal of the American Chemical Society*, xxviii., No. 11.

THE ATOMIC WEIGHT OF COBALT.

$CoCl_2 : 2Ag.$
$Cl = 35{\cdot}473.$

Series I.
Ag = 107·930.

Number of analysis.	Sample of $CoCl_2$.	Weight of $CoCl_2$ in vacuum. Grms.	Weight of residue. Grm.	Change in weight of boat. Grm.	Weight of silver in vacuum. Grms.	Loss on fusion. Grm.	Weight of silver added or subtracted. Grm.	Corrected weight of $CoCl_2$. Grms.	Corrected weight of silver. Grms.	Atomic weight of cobalt.
1	I.	1·09971	0·00007	+0·00005	1·82659	0·00016	+0·00012	1·09959	1·82671	58·991
2	I.	1·47808	0·00009	+0·00066	2·45404	0·00028	−0·00006	1·47733	2·45398	59·005
3	II.	3·84144	0·00011	0·00000	6·38106	0·00040	−0·00025	3·84133	6·38081	59·005
4	II.	3·64357	0·00015	0·00000	6·05223	0·00038	+0·00009	3·64342	6·05232	58·999
5	II.	2·96330	0·00015	—	4·92221	0·00023	+0·00023	2·96315	4·92244	58·995
6	II.	3·48435	0·00017	—	5·78776	0·00039	+0·00039	3·48418	5·78815	58·991
7	II.	3·29530	0·00007	—	5·47391	0·00019	+0·00019	3·29523	5·47410	58·995
8	I.	1·57670	0·00015	—	2·61889	0·00016	+0·00016	1·57655	2·61905	58·992
									Average ..	58·997

Series II.

Number of analysis.	Sample of $CoCl_2$.	Weight of $CoCl_2$ in vacuum. Grms.	Weight of residue. Grm.	Change in weight of boat. Grm.	Weight of AgCl in vacuum. Grms.	Loss on fusion. Grm.	Weight of asbestos. Grm.	Weight of AgCl from wash-waters. Grm.	Corrected weight of $CoCl_2$. Grms.	Corrected weight of AgCl. Grms.	Atomic weight of cobalt.
9	I.	1·09971	0·00007	+0·00005	2·42529	0·00011	0·00016	0·00142	1·09959	2·42676	59·009
10	I.	1·47808	0·00009	+0·00066	3·25929	0·00028	0·00006	0·00288	1·47733	3·26095	58·988
11	II.	3·84144	0·00011	0·00000	8·47596	0·00040	0·00000	0·00179	3·84133	8·47735	59·014
12	II.	2·96330	0·00015	—	6·53901	0·00038	0·00035	0·00121	2·96315	6·54019	58·997
13	II.	3·48435	0·00017	—	7·69032	0·00058	0·00017	0·00093	3·48418	7·69084	58·986
14	II.	3·29530	0·00007	—	7·27146	0·00049	0·00018	0·00169	3·29523	7·27284	59·002
15	I.	1·57670	0·00015	—	3·47946	0·00032	0·00011	0·00087	1·57655	3·48012	58·982
									Average ..		58·997
									Average of Series I. and II. ..		58·997

found in this laboratory by Richards and Stähler that if the solution is made slightly alkaline with ammonia and then is acidified immediately before being tested, more accurate results are obtained (*Am. Chem. Journ.*, 1906, xxxv., 512). This procedure was followed in the greater part of our analyses. The testing took place very shortly after the filtration, so that suspended material had no time to settle.

After the filtrate and wash-waters had been analysed for dissolved silver chloride, they were filtered through a tiny filter to collect a small quantity of asbestos mechanically detached from the Gooch crucible. This filter was washed with ammonia to eliminate the silver chloride, which might have been collected and which had been determined in the nephelometric test, and was ignited in a weighed platinum crucible.

For most of the work a new short-armed Troemner balance, sensitive to a fiftieth of a mgrm. with a load of 50 grms., was used. The gold-plated brass weights were three times carefully standardised to hundredths of a mgrm. and were used for no other work. Weighings were made by substitution with counterpoises as nearly like the objects to be weighed as possible.

In order that the proper vacuum correction for cobaltous chloride might be applied, the density of this substance was determined by Dr. M. A. Hines in connection with similar work upon manganese. The salt was first fused in a platinum boat in a current of hydrochloric acid gas, and then the toluene displaced was determined with a pycnometer previously described (Baxter and Hines, *Am. Chem. Journ.*, 1904, xxxi., 220).

Density of $CoCl_2$. (*Density of Toluene* = 0·86166).

Weight of $CoCl_2$ in vacuum.	Weight of toluene displaced in vacuum.	Density of $CoCl_2$.
Grms.	Grms.	25°/4°.
4·8719	1·2522	3·352
4·6520	1·1991	3·343
	Average ..	3·348 (*a*)

(*a*) Playfair and Joule obtained the value 2·937. Landolt-Bornstein, "Physikalisch-Chemische Tabellen," 3rd Ed., p. 238.

The following vacuum corrections were applied:—Cobaltous chloride, +0·000215; silver, −0·000029; silver chloride, +0·000073.

Evidence of the purity of the silver and of the absence of appreciable occlusion by the silver chloride may be obtained from the relation between the amount of silver used in the titrations and the corresponding amount of silver chloride formed. In all, 29·46524 grms. of silver produced 39·14905 grms. of silver chloride, a ratio of 100·000 to 132·865. Richards and Wells found this ratio to be 100·000 to 132·867.

Attention should be called to the fact that if the salt made from the amine still contained appreciable amounts of ammonium chloride after being heated, the observed value for the atomic weight of cobalt would have been too low. On the other hand, if the cobaltous chloride made from the crystallised salt retained traces of water, the result would have been too high. The average of all the results obtained with salt made from the amine is 58·995, and the average of the results with salt made from the crystallised chloride is 58·998. The very slight difference between these values lies within the experimental error of the determinations. Evidently, the salt was in all cases essentially free both from ammonium chloride and water. The almost complete absence of ammonium chloride was also shown by two experiments in which the amine was heated in a current of hydrochloric acid in the usual manner, and then the salt was dissolved in water, and the cobalt was precipitated by the addition of ammonia-free sodium hydroxide. In one case where 1·76 grms. of cobaltous chloride were used, the filtered solution, when tested with Nessler's reagent, showed the presence of 0·00025 grm. of ammonium chloride, while in the other 2·13 grms. of cobaltous chloride yielded 0·00005 grm. of ammonium chloride. This proportion of impurity would have lowered the observed atomic weight 0·004 in the first case, and only 0·001 in the second. The average 0·003 is exactly the difference between the averages from the two samples of material. If this correction is applied in the analyses where the cobaltamine was used, the averages of both Series I. and Series II. are raised to 58·998, a negligible change.

Whether or not such a correction is applied the average of Series I. and II. confirms very closely the value 58·995 previously found by analysis of the bromide; hence the atomic weight of cobalt may, as before, be assumed to be 59·00 referred to silver 107·930.

We are deeply indebted to the Cyrus M. Warren Fund for Research in Harvard University for many platinum, quartz, and other vessels.

RAPID METHODS FOR THE ESTIMATION OF ROSIN IN PAPER.

By CLAYTON BEADLE.

MANY methods have been proposed for the estimation of rosin in paper, but they are all more or less open to objection. Difficulties in connection with most of these processes I have dealt with in detail in communications to technical journals devoted to paper-making.

There is an objection common to all these processes, particularly when dealing with common papers, namely, that the fibres themselves contain resinous matter, often in sufficient quantity to entirely obscure the actual amount of rosin added for the purposes of sizing. Unfortunately, there is no acknowledged method of distinguishing between rosin added as rosin size and rosin or resinous bodies pre-existing in the fibrous furnish of the paper, particularly when we have regard to the fact that the rosin (colophony), common and natural to the fibres themselves, is, as in the case of chemical and mechanical wood pulp, the same in chemical nature and reactions as the rosin of the rosin-size.

A common method for the qualitative determination of rosin in paper is to boil the paper in absolute alcohol or rectified spirit for a few minutes, cool, and add the alcoholic extract to cold distilled water. If rosin be present, on dilution with water it becomes precipitated, and produces a cloudiness. The extraction is conveniently done on 0·10 grm. of paper in a small test-tube (12 mm. diameter) with 2 cc. of absolute alcohol. This, after cooling, is carefully poured on to the surface of distilled water in a second and similar test-tube filled to within an inch of the top. At the point at which the alcohol and water meet, an opaque ring or layer of precipitated rosin is gradually developed. If a number of papers are under examination and equal weights and volumes be taken, a comparison of the zones after standing four hours gives one a rough idea of the relative proportions of the rosin in each of the samples. If now the liquids are mixed by placing the thumb over the tube and inverting two or three times, and the tubes are chosen of equal diameters; the comparative opacities of the different liquids also gives one a rough and perhaps a more accurate idea of the relative proportions.

Unfortunately, there are occasionally other substances than rosin present in paper and soluble in absolute alcohol, which give also a cloudiness on dilution with water. These substances can, as a rule, be detected and sometimes allowed for. The writer has for a long time made use of a quantitative process based on the above method. The procedure is as follows:—

A standard solution of rosin is made up by dissolving 1 grm. air-dry commercial colophony in 1000 cc. of absolute

alcohol. This is of such a strength that 1 cc. of the standard rosin solution is equal to 1 per cent of rosin on 0·1 grm. of paper. 0·1 grm. of the paper to be examined is cut into small fragments, placed in a small clean test-tube, and 2 cc. of absolute alcohol added. It is raised to boiling, allowed to stand for fifteen minutes, raised again, and the extract decanted into another clean tube. The paper is treated with a second and third quantity of absolute alcohol in a similar manner. The clear extract is cooled to 15° C., and added to a test-tube containing cold distilled water, three parts filled, shaken, and allowed to stand ten minutes. I prefer ordinary test-tubes to Nessler tubes for this purpose. To another test-tube of colourless glass and of exactly the same diameter containing the same volume of water, is added from a burette some of the standard rosin solution in different trial lots, until the exact opacity is matched. In this manner the amount of rosin in some papers can be determined within 0·1 per cent.

The process was tested by a number of blank experiments, using rosin-free filter-paper, to which known percentages of rosin dissolved in alcohol had been added. The opacity increases somewhat on standing, so that a few minutes must be allowed before final reading. It is also found necessary to add the standard rosin all at once.

A usual method for the determination of rosin in paper is to place, say, from 2 to 5 grms. of paper in a Soxhlet, exhaust with alcohol, and weigh the residue in a flask in the usual manner.

The author has proved by a number of careful experiments, the results of which have already been published in detail, that the results obtained by this method are not so satisfactory as those obtained by the volumetric method above described, as they include other substances soluble in alcohol which do not give a precipitate on the dilution of water. Moreover, there are almost always substances extractable by alcohol contained even in the purest bleached cotton and linen fibres; these we find are seldom below 0·4 per cent

There are other methods, one of which is based upon the saponification of rosin by boiling with aqueous soda and its subsequent precipitation with acid, and its determination either volumetrically or gravimetrically. Such processes are unsatisfactory on account of removal by soda or other substances such as lignin, particularly in papers containing lignified fibres such as jute and mechanical wood.

It remains but to refer to attempts made by the author to utilise the Raspail reaction, both for the qualitative and quantitative estimation of rosin in paper. A number of experiments made by partially immersing strips of paper of known composition in strong sulphuric acid show that the pink coloration could not be relied upon as an indication of the presence of rosin when the paper consisted of impure celluloses, but when pure it is useful as a check test.

Having devised a volumetric process for the quantitative estimation of rosin in paper, it becomes necessary to distinguish between the rosin or resinous bodies natural to the fibres, and the rosin added as rosin-size to the paper. The distinguishing feature between these two conditions of the rosin is to be found in the fact that resinous bodies natural to the fibre do not produce a sizeing effect. The author has examined an adaptation of Hertzberg's method on the lines recommended by Mr. James Strachan, and has found it to be very useful as a guide, particularly when done in conjunction with foregoing volumetric method.

The evidence as to the presence of rosin in the process about to be described is chiefly based upon the difference in sizeing effect in the paper before and after the removal of the rosin by treatment with ether. The principle of this spot test with ether can be explained in a few words. If a drop of ether be applied to paper sized with rosin, the rosin is dissolved. If the ether be allowed to evaporate very slowly the dissolved rosin will be restored to the fibres of the paper again; in other words, the distribution of the rosin will be the same as before the spot of ether had been applied. If, however, the ether is rapidly evaporated the rosin will form a ring or fringe round the edge of the drop, leaving the interior of the drop in a more or less unsized condition. The same condition of affairs can be exemplified by placing two drops of brine on the surface of the blotting paper—one of which is evaporated slowly and the other quickly. That which evaporates rapidly forms a crystalline fringe round the edge, whereas the slow evaporation will give rise to crystals distributed all over the surface.

J. Strachan's method of applying Hertzberg's ether test is as follows:—

On the exact spot on the sample to be tested a small cross mark is made with a pencil, so that the spot to which the ether is applied may be at once located. The paper is then rolled or bent slightly in the two directions of the sheet, so that the surface presents a slightly hollow appearance. This is done for the reason that on a convex or even flat surface ether spreads rapidly, but when carefully applied to a slightly concave surface the tendency to spread is checked very considerably. The paper is then warmed by simply holding it four or five inches above a wire gauze resting on a tripod stand, under which is placed a small Bunsen burner. While in this position ether is applied from a small pipette (preferably 5 cc. capacity) containing about ten drops, whilst the finger is pressed against the top of the pipette. It should be done at such a distance that the warmth of the hot air rising from the burner is just sufficient to expel the ether very gently and in fairly large drops. For some papers a single drop is enough. It is generally advisable to apply two or more drops, taking care that the second is applied just before the first is completely evaporated, and so on. In some samples, however, five or six drops are required to sufficiently develope the ring of resin. The ring appears quite distinctly at first (immediately after test), but after an hour or so it fades somewhat. For this fading we have not at present formed an explanation. After the test is applied the paper is examined in a good light. If resin be present it shows as a very narrow dark coloured zone fringing the edge of the spot, *i.e.*, where the ether evaporated most quickly. The central portion within this zone, in the case of a white paper, presents a whiter appearance by reflected light than the rest of the sheet. By transmitted light the reverse is the case, because this portion having most of the rosin abstracted from it becomes more opaque than the rest of the sheet, whilst the zone of rosin, which is the darkest portion of the sheet by reflected light, becomes the most translucent by transmitted light. In a quick test, after application of the ether, the rosin zone is best revealed by holding the paper between the light and the observer.

When the rosin-ring is somewhat faint, Strachan combines another of Hertzberg's tests with the one above referred to, viz., the tannic ether ferric chloride test, with the result that an almost invisible ring is instantly developed; this, if done with care, is very striking.

The ferric chloride is applied with a pen in the manner prescribed by Hertzberg, and the ether solution of tannic acid is applied to the other side of the paper with a glass rod. By transmitted light the portion deprived of rosin is black, the rosin ring fairly clear, and that portion outside the ring is more or less blackened according to the degree to which the paper is sized with rosin, and the strength of the applied solutions, &c. A 1 per cent aqueous solution of tannic acid may be used instead of the ether solution, but the ethereal solution is to be preferred.

The substitution of alcohol for ether is not to be recommended, chiefly on account of the slower evaporation of the former, and, as already pointed out, rapid evaporation is essential for the production of a satisfactory zone of resin.

It is found convenient to apply the ferric chloride solution with a fine pointed gold pen. The test may be quickened and simplified in various ways, such as by taking a narrow strip of the sample to be tested, folding it one end so as to form a V-shaped hollow, the paper being

held by the unfolded end. Into the V-shaped end the drops of ether are applied at a spot about 15 mm. from the free end, whilst the strip is held in a horizontal position. The ether is applied drop by drop over a Bunsen flame, as above described. A glass tube drawn out to a fine orifice is dipped into Stephens' blue-black ink, and drawn lightly over the surface and parallel with edge of the strip. As it passes over the treated portion, it will be noticed that on the untreated part the ink stands upon the surface, but immediately sinks into the middle of the spot, and refuses entirely to penetrate the point where the line of ink intersects the fringe of deposited rosin.

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

By ARTHUR A. NOYES and WILLIAM C. BRAY.

INTRODUCTION.—OUTLINE OF THE INVESTIGATION.

THIS investigation was undertaken for the purpose of studying the processes of qualitative analysis in general use, with reference to their effectiveness in enabling small quantities of each of the more common elements or element-groups to be detected in the presence of any of the other elements, and for the purpose of selecting the methods best adapted to this end and of improving them wherever desirable and practicable. In spite of the vast number of text-books on qualitative analysis in which more or less different processes are recommended, there seems to have been made in recent years no exact systematic study of the relative effectiveness of the separations or of the delicacy of the final tests. It has seemed to us, therefore, worth while to make a detailed investigation of this kind; and as a result of it to develop, if possible, a system of analysis which will enable a quantity of any element as small as one or two mgrms. to be detected in any mixture. Effort will also be made to employ only such processes as enable a rough estimate to be made of the quantity of the various elements present; for this is usually a more important function of a good qualitative analysis than the mere determination of their presence or absence. To this end tests of excessive delicacy, like certain colour reactions, will be avoided, and each element will be obtained in the solid form as a precipitate or residue, as far as possible.

Especial attention will also be devoted to the chemical reactions involved in the process and to the explanations of them furnished by the Mass-Action Law and Ionic Theory. Since the first systematic application of modern theories to analytical chemistry was made by Ostwald, many physico-chemical researches have been published which make it possible to give such explanations with certainty in a greater number of cases. References to the more important articles relating to the chemistry of the processes and to their theoretical interpretation will be given.

The elements and element-groups included in this system of analysis are primarily those which, with remarkable unanimity, are treated of in the ordinary schemes of qualitative analysis, but we have also introduced the more important of the so-called rare elements, in so far as this has seemed practicable without seriously complicating or modifying the process best adapted to the more common elements. An independent "System of Qualitative Analysis Including nearly all the Metallic Elements" is also being worked out in the Laboratory of Physical Chemistry, Massachusetts Institute of Techology; and parts of it have already been published under this title in the *Technology Quarterly*. The latter scheme differs from the one here presented in that the detection of the rare elements forms the essential feature, instead of a merely incidental one.

The results will be presented in the form that seems best adapted to the purposes of the analyst. The "System of Analysis" is for convenience in publication primarily divided into a series of parts, each of which treats of one of the large divisions of the subject. Under each part is first presented a "General Discussion," in which are given the reasons for the adoption of the process employed. This is followed by a "Tabular Outline," which gives a survey of the important steps and the chemical reactions involved in the process of analysis. Then comes the chapter entitled "Procedures and Notes," in which the details of the process are presented and discussed. Next are given the "Test Analyses," which were made with known mixtures in order to test the efficiency of the process. Finally are presented "Confirmatory Experiments and References," which serve to substantiate the statements made in the notes and to justify the details of the procedures.

In the procedures the operations are described in much detail; it is, however, assumed that the analyst is familiar with the manipulative processes of exact qualitative analysis and with the ordinary precautions for assuring completeness of precipitating, washing, &c. In the notes are explained the purposes of the operations and the specific chemical reactions involved from the point of view of the Mass-Action Law and the Ionic Theory, with the general principles of which the reader is assumed to be acquainted. The directions are almost always given in the form applicable to the case where all elements that might be present are present, the modifications admissible when certain operations lead to negative results being usually sufficiently evident. The scheme consists of a series of numbered "Procedures," a new one being begun whenever the substance has been resolved into two parts (such as a precipitate and filtrate) which are to be submitted to different operations. Procedures which are devoted to the detection or separation of the rarer elements are preceded by an asterisk, and are further designated by a letter attached to the procedure number; they may be omitted if such elements are not to be tested for. Notes under other procedures, when they relate to such elements, are also distinguished by an asterisk. At the beginning of each procedure the one by which the substance was last treated, and at the end of each procedure those by which the two separated portions of it are next to be treated, are referred to by number.

Most of the experiments described under "Confirmatory Experiments and References" are undoubtedly merely confirmations of previously known chemical facts. The application of these facts to the specific conditions of the procedures it was, however, constantly necessary to test; and it has seemed worth while to make the results a matter of record. The experiments are preceded by a reference to the procedure and note to which they relate.

Of the abbreviations employed only a few need be explained:—G. D. is used for General Discussion; P., for Procedure; N., for Note; C. E., for Confirmatory Experiments; T. A., for Test Analyses. A number within parentheses expresses the specific gravity at 15°. When it is directed to add a variable quantity of a reagent (for example, 5—15 cc.), the amount used should be adjusted to the size of the precipitate or residue.

The metallic elements have been classified in "Groups" on the basis of their behaviour toward the general ("group") reagents, and these groups are designated and defined as follows, the rarer elements here considered being indicated by an asterisk:—*Silver group*, elements precipitated wholly or in part by hydrochloric acid (Ag, Pb, Hg [mercurous], *Tl); *copper group*, elements precipitated by hydrogen sulphide from weakly acid solution whose sulphides remain undissolved in large quantity by yellow ammonium sulphide (Hg [mercuric], Pb, Bi, Cd, Cu, *Au, *Pt); *tin group*, elements precipitated by hydrogen sulphide from weakly acid solution whose sulphides dissolve readily or in considerable quantity in yellow ammonium sulphide (As, Sb, Sn, *Au, *Pt. *Se, *Te, *Mo); *iron group*, elements not precipitated by hydrogen sulphide from acid solution, but precipitated by ammonium

* From the *Technology Quarterly*, xix., No. 3, September, 1906.

hydroxide and sulphide (Co, Ni, Fe, Mn, Cr, Al, Zn, *Ti, *Zr, *U, *V, *Be); the *alkaline-earth group*, elements not precipitated by any of these reagents, but precipitated by ammonium carbonate (Ba, Sr, Ca); the *alkali group*, elements not precipitated by any of the preceding reagents (Mg, Na, K, *Li).

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, February 7th, 1907.

Prof. R. MELDOLA, F.R.S., President, in the Chair.

MR. H. S. REDGROVE was formally admitted a Fellow of the Society.

The PRESIDENT gave expression to the deep sense of loss experienced by Fellows of the Society through the death, on February 2nd, of Professor Dmitri Ivanovitsch Mendeleeff, F.R.S., and of Professor Nicolai Menschutkin, which occurred on February 5th. These chemists were Honorary and Foreign Members of the Society, having been elected in 1883 and 1898 respectively.

Certificates were read for the first time in favour of Messrs. John Campbell Allan, 91, Norse Road, Scotstoun, Glasgow; Francis James Bailey, Findon Hill, Sacriston, Durham; Charles Stanley Gibson, B.A., 45, Shakespeare Street, Manchester; Joshua Craven Gregory, B.Sc., F.I.C., 126, Woodlands Road, Glasgow; John Robinson, Agricultural College, Aspatria, Cumberland.

Of the following papers, those marked * were read:—

*20. "*The Rapid Electro-analytical Deposition and Separation of Metals.* Part I. *The Metals of the Silver and Copper Groups and Zinc.*" By HENRY JULIUS SALOMON SAND.

The experiments on a new electro-analytical method of rapid determination and separation of metals referred to in a preliminary note (*Proc.*, 1906, xxii., 43) have been continued. The metals hitherto studied are silver, mercury, copper, bismuth, lead, cadmium, and zinc. With the exception of the separation silver-mercury, each metal has been successfully separated from all the others by the method of graded potential. In order to separate silver from mercury the metals were deposited together, converted into their cyanides, and these separated in the usual way by means of their different behaviour to acids. The silver was then estimated electrolytically in the pure silver cyanide obtained. Experiments have been carried out in which the seven metals studied have been quantitatively separated from one solution. The silver was separated from the mercury as described above, and the lead and part of the bismuth were removed on the anode. All the other separations were brought about by graded potential. The metals were deposited in the following sequence:—1. Mercury and silver. 2. Lead and part of bismuth on anode; copper and rest of bismuth on cathode. 3. Cadmium. 4. Zinc. 5. After dissolving the combined deposit of copper and bismuth, the latter was estimated. 6. Rest of bismuth separated from lead after dissolving the deposit. 7. Lead. 8. Cadmium tested for traces of lead. One evaporation was necessary. The time required for the depositions in these experiments varied between five and fifteen minutes.

DISCUSSION.

Mr. EDWARD GARDNER asked if the author had had any experience in depositing copper from solutions containing a large quantity of ferric sulphate, and whether he had been able, in such solutions, to obtain an adherent deposit by any method of graded potential.

Mr. SAND stated that the presence of metals of variable valency, such as iron, which pass from one stage of oxidation to another with extreme readiness, caused much difficulty. Work on such cases was being carried out at present.

*21. "*The Alkaloids of Ergot.*" By GEORGE BARGER and FRANCIS HOWARD CARR.

The authors assign to Tanret's crystalline ergotinine the formula $C_{35}H_{39}O_5N_5$, and have abandoned the formula $C_{28}H_{32}O_4N_4$, provisionally suggested in a preliminary note communicated to the British Association (CHEMICAL NEWS, 1906, xciv., 89). Tanret's original formula, $C_{35}H_{40}O_6N_4$, was based on faulty nitrogen determinations. In the above mentioned note, the authors suggested the name ergotoxine for a second amorphous ergot alkaloid, of which they had crystallised several salts. Subsequently, this alkaloid was described by Kraft (*Arch. Pharm.*, 1906, ccxliv., 336) as hydroergotinine, because by boiling its solution in methyl alcohol it was converted into ergotinine. Kraft did not analyse hydroergotinine.

In an attempt to acetylate ergotoxine with acetic anhydride the authors obtained ergotinine. As the latter alkaloid contains no acetyl group the change must be due to dehydration. The reverse change occurs when an ergotinine solution in dilute phosphoric acid is boiled. The crystalline phosphate of an amorphous alkaloid is then formed, closely resembling ergotoxine phosphate.

For ergotoxine the formula $C_{35}H_{41}O_6N_5$ is deduced from the analyses of the free base and of the following crystalline salts:—

$C_{35}H_{41}O_6N_5,HCl$, m. p. 205°; $C_{35}H_{41}O_6N_5,H_3PO_4,H_2O$, m. p. 186—187°; $C_{35}H_{41}O_6N_5,C_2H_2O_4$, m. p. 179°; and $(C_{35}H_{41}O_6N_5)_2,C_2H_2O_4$, m. p. 179°.

The two formulæ, $C_{35}H_{39}O_5N_5$ and $C_{35}H_{41}O_6N_5$, thus independently arrived at for the crystalline and the amorphous alkaloid respectively, establish the theory, first put forward by Kraft, that the former is the anhydride of the latter.

In contradistinction to ergotinine, ergotoxine is strongly active physiologically, producing all the typical effects of ergot. It is contained in most commercial specimens of ergotinine, and also in Tanret's so-called "amorphous ergotinine."

DISCUSSION.

Dr. BYWATERS asked whether other alkaloids were known which passed from an inactive to an active form by being simply hydrated, and whether the fact of the active alkaloid being amorphous and forming a colloidal solution did not indicate that it was rather polymerisation instead of hydration that had occurred.

Dr. BARGER stated that some alkaloids were known which behave similarly to those mentioned in the paper. The salts of both alkaloids formed colloidal solutions under certain conditions.

*22. "*Influence of Substitution on the Formation of Diazoamines and Aminoazo-compounds.* Part VI. *The Partially Methylated* 4:6-*Diamino*-m-*xylenes.*" By GILBERT THOMAS MORGAN and FRANCES MARY GORE MICKLETHWAIT.

In examining the effect of substitution on the formation of *o*-amino-azo-compounds of the benzene series, the authors have methylated progressively 4:6-diamino-*m*-xylene, and have studied the action of diazonium salts on the products. *Methyl*-4:6-*diamino*-m-*xylene* yields azo-derivatives like the unmethylated diamine itself, but as-*dimethyl*-4:6-*diamino*-m-*xylene* and *trimethyl*-4:6-*diamino*-m-*xylene* furnish stable diazoamines which are accompanied only by traces of azo-compounds.

DISCUSSION.

The PRESIDENT congratulated Dr. Morgan on the extreme ingenuity of the method by which he had effected the progressive methylation of these substituted *meta*-diamines. He asked with reference to the possible formation of aminoazo-compounds with the azo- and dimethyl-amino-groups in the *ortho*-position whether the action o

the usual transforming agents on the corresponding diazoamines had been tried, and if so with what result.

In reply to Dr. Cain's suggestion that steric hindrance might be the cause of the non-formation of azo-derivatives from tetramethyl-4 : 6-diamino-*m*-xylene, Dr. Morgan preferred to take the view that the absence of a labile hydrogen atom attached to nitrogen was the inhibiting factor. The non-formation of *ortho*azo-derivatives from tertiary amines was a general rule, which held both in the benzene and naphthalene series, whereas the phenomena attributed to steric hindrance in one of these series were frequently not manifested in the other.

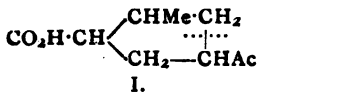
In reply to the President he stated that repeated attempts to transform the diazoamines of the *as*-dimethyl- and trimethyl-4 : 6-diamino-*m*-xylenes had not led to the isolation of definite aminoazo-compounds.

*23. "*The Constitution of Umbellulone.* Part II. *The Reduction of Umbellulonic Acid.*" By Frank Tutin.

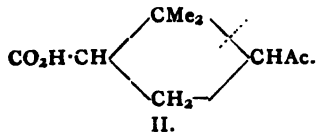
When umbellulonic acid, $C_9H_{14}O_3$, obtained by the oxidation of umbellulone (*Trans.*, 1906, lxxxix., 1104), is reduced by means of sodium and alcohol, a *hydroxy-acid* having the formula $C_9H_{18}O_3$ is produced. It is evident from this fact that the ring contained in umbellulonic acid has been opened by the addition of two atoms of hydrogen, and the resulting hydroxy-acid must therefore be a chain-compound.

This hydroxy-acid gives a *lactone* (b. p. 246—248°), and when oxidised with permanganate in presence of an excess of alkali yields acetic and *iso*propylsuccinic acids.

In the previous communication (*loc. cit.*) it was shown that umbellulonic acid must contain either a methylpentamethylene or a dimethyltetramethylene ring. Only two keto-acids containing either of these rings are capable of giving on reduction a hydroxy-acid, which, by subsequent oxidation, would yield acetic and *iso*propylsuccinic acids, namely, those possessing the following formulæ :—



I.



II.

A hydroxy-acid which would yield on oxidation acetic and *iso*propylsuccinic acids, could only be formed from one of the above keto-acids by the opening of the ring on reduction at the place indicated by the dotted line. The product of the reduction of umbellulonic acid will therefore be *δ-hydroxy-*α*-iso*propyl*-n-*hexoic acid*,—

$$CH_3{\cdot}CH(OH){\cdot}CH_2{\cdot}CH_2{\cdot}CH{\cdot}(CO_2H){\cdot}CH(CH_3)_2.$$

Formula II. represents pinononic acid, and it has previously been shown that umbellulonic acid is neither identical nor stereoisomeric with this compound. Umbellulonic acid must therefore be correctly represented by Formula I.

It follows from this that the correctness of the formula previously assigned to umbellulone cannot be doubted.

*24. "*The Reduction of Hydroxylaminodihydroumbelluloneoxime.*" By Frank Tutin.

Hydroxylaminodihydroumbelluloneoxime was prepared by Power and Lees in their investigation of the essential oil of *Umbellularia Californica* (*Trans.*, 1904, lxxxv., 636). When reduced with sodium and alcohol it gives a *base* (b. p. 136—138°/50 mm.), which is a liquid soluble in water. From the results obtained by the analysis of the *dibenzoate*, *dihydrochloride*, and *dibensoyl* derivative of this base it is impossible to say with certainty whether it has the formula $C_{10}H_{20}N_2$ or $C_{10}H_{22}N_2$, although it is most probable that the latter is correct. The base may therefore be designated *aminotetrahydroumbellulylamine*.

Aminotetrahydroumbellulylamine dibenzoate crystallises in needles melting at 212—213° ; the *dihydrochloride* also forms needles, but it is infusible at 305°. *Dibenzoylaminotetrahydroumbellulylamine* crystallises in prisms or in leaflets, which melt at 194°.

Although evidence was obtained of the presence of bases which are probably stereoisomeric with aminotetrahydroumbellulylamine, no derivative of them could be isolated n a state of purity.

25. "*Studies on Optically Active Carbimides*: Part V. *The Aryl Esters and the Amides of* l-*Menthylcarbamic* i*Acid.*" By Robert Howson Pickard and William Oswald Littlebury.

A continuation of the investigation of derivatives of menthylamine (see *Proc.*, 1905, xxi., 286). Eleven aryl esters and eighteen amides of *l*-menthylcarbamic acid were described, and the rotations of these when dissolved in chloroform and pyridine compared. Attention was drawn to the approximately constant molecular rotation given by certain derivatives of menthylamine and menthol.

26. "*Some Constituents of Natural Indigo.*" (Part I.). By Arthur George Perkin and William Popplewell Bloxam.

Indigo-brown, an impurity of natural indigo, is best isolated by means of boiling pyridine. The crude product contains, in addition to small quantities of indirubin and a colourless wax, certain brown amorphous substances, of which the compound (*a*), $C_{16}H_{12}O_3N_2$, is present in by far the largest amount. This substance is insoluble in all the usual solvents except pyridine, but dissolves in alkali hydroxide solutions, and is readily reduced in this condition. When digested with strong aqueous potassium hydroxide it is converted into anthranilic acid and an amorphous brown substance of uncertain composition. Two closely allied compounds (*b*) and (*c*) present in but small amount have been isolated, the former of which is soluble in acetic acid and insoluble in alcohol, whereas the latter dissolves in alcohol. These substances, to which the respective compositions $C_{24}H_{22}O_5N_3$ and $C_{16}H_{14}O_4N_2$ are ascribed, closely resemble in general properties the compound $C_{16}H_{12}O_3N_2$, and from them also anthranilic acid was obtained. It is considered possible that these brown compounds are derivatives or condensation products of indoxyl, which are formed from indican during the process of manufacture. The leaves of the *Indigofera arrecta* and *I. Sumatrana* are practically devoid of tannin matter.

27. "*The Occurrence of Isatin in some Samples of Java Indigo.*" By Arthur George Perkin.

During the examination of samples of Java indigo rich in indirubin, for yellow colouring matter (*Proc.*, 1904, xx., 172) by extraction with sodium carbonate solution and isolation of the products from the neutralised liquid with ether, there was obtained in addition to kampherol a small amount of substance crystallising from benzene in orange needles melting at 200°. This gave the thiophen reaction and was found to consist of isatin. The quantity present was exceedingly small, and in many other samples it appeared to be absent, but the point is interesting as it indicates that the formation of indirubin during the manufacture of natural indigo follows the well known synthesis of Baeyer (*Ber.*, 1881, xiv., 1745). Indirubin appears to be most readily formed when the fermented plant extract is oxidised under slightly alkaline conditions, and in these circumstances the oxidation of a portion of the indoxyl to isatin would appear to be facilitated.

28. "*The Absorption Spectra of Benzoic Acid, the Benzoates, and Benzamide.*" By Walter Noel Hartley and Edgar Percy Hedley.

The absorption spectra of benzoic acid and phthalic acid were photographed by Hartley and Huntington, and characteristic bands were found in both; those of the

former being situated between λ 280 and λ 270 with a continuous absorption beyond λ 255.

In a paper by Baly and and Collie (*Trans.*, 1905, lxxxvii., 1332) it is stated that "The spectrum of benzoic acid has been observed by Hartley and Huntington (*Phil. Trans.*, 1879, clxx., I., 257) and only shows general absorption rather strongly. This is only to be expected from the presence of the ketonic oxygen in the β-position."

As many benzoyl derivatives show absorption bands in their spectra, including benzaldehyde, it was considered necessary to settle this question decisively.

The absorption curves of benzoic acid, potassium and silver benzoates, and benzamide have been drawn from the photographs of the spectra of these substances, which were specially prepared and were of great purity and finely crystallised. The absorption bands of the different substances are all obviously related to the bands in benzoic acid, and the absorption is due to the benzene ring.

29. "*The Absorption Spectra of Phthalic, Isophthalic, and Terephthalic Acids, Phthalic Anhydride, and Phthalimide.*" By Walter Noel Hartley and Edgar Percy Hedley.

Phthalic acid was examined by Hartley and Huntingdon (*Phil. Trans.*, 1879, clxx., I., 257), but the isomeric acids have not been investigated. The sparing solubility of terephthalic acid rendered it necessary for its examination to convert it into the dimethyl ester and to examine salts of the acid. It was found that phthalic anhydride, dissolved in cold alcohol, gave no absorption band, but that after warming for five minutes the spectrum showed a marked extension, and finally a strong absorption band was developed.

Phthalimide underwent no such change; it is therefore apparent that the group $\begin{matrix}CO\\CO\end{matrix}>NH$ is more stable than $\begin{matrix}CO\\CO\end{matrix}>O$.

o-Phthalic acid gives an absorption curve of the character that might be expected from a comparison with that of benzoic acid and from the difference in constitution between the two.

*iso*Phthalic acid has a shallow band of absorption situated in the same position as that of phthalic acid, but it is much less persistent.

Terephthalic acid being insoluble, its dimethyl ester and salts were examined, and it was found that the acid has no band, but merely an extension at or near where a band might be expected.

39. "*αα'γ-Trimethyl- and αα'γγ'-Tetramethyl-Tricarballylic Acids and αδ-Dimethylbutane-αβδ-Triearboxylic Acid.*" By Henry Henstock and Charles Henry Graham Sprankling."

In a former communication by Bone and Sprankling, a method was given for the preparation of alkyl tricarballylic acids in alcohol solution; in the case of the acids here discussed, the method has been modified and toluene was used instead of alcohol. The two reactions, (1) the condensation of the sodium compound of β-methylcyanosuccinic diethyl ester with α-bromo*iso*butyric ethyl ester, and (2) the condensation of the sodium compound of ββ-dimethylcyanosuccinic diethyl ester with α-bromopropionic ester, should both yield products from which, on hydrolysis, αα'γ-trimethyltricarballylic acid should be obtained. It was found, however, that in reaction (1) αδ-dimethylbutane-αβδ-tricarboxylic acid is produced; probably hydrogen bromide is first eliminated from α-bromo*iso*butyric ester, and the resulting methylacrylic ester condenses with the sodium compound of β-methylcyanosuccinic ester as follows:—

$$CO_2Et\cdot CHMe\cdot CNa(CN)\cdot CO_2Et + CH_2:CMe\cdot CO_2Et = CO_2Et\cdot CHMe\cdot C(CN)(CO_2Et)\cdot CH_2\cdot CMeNa\cdot CO_2Et.$$

Reaction (2) yields αα'γ-trimethyltricarballylic acid.

The condensation of ββ-dimethylsodiocyanosuccinic diethyl ester with α-bromo*iso*butyric ester furnishes a product which, on hydrolysis, yields αα'γγ'-tetramethyltricarballylic acid.

31. "*A Reaction of certain Colouring Matters of the Oxagine Series.*" By Jocelyn Field Thorpe.

Those colouring matters of the oxazine series which are derivatives of phenonaphthoxazine containing amino- or substituted amino-groups in the position 6 of the phenonaphthoxazine ring, are readily converted into the corresponding phenonaphthoxazone by warming on the water-bath in the presence of very dilute acids. Thus Nile-blue A (3-diethylamino-6-aminophenonaphthoxazine sulphate) and Nile-blue 2B (3-diethylamino-6-benzylaminophenonaphthoxazine chloride) are converted into 3-diethylaminoophenonaphthoxazone, melting at 204°, whereas New Methylene-blue GG (3 : 6-tetramethyldiaminophenonaphthoxazine chloride) and New Blue B (3-dimethylamino-6-dimethylaminophenylaminophenonaphthoxazine chloride) are converted into 3-dimethylaminophenonaphthoxazone, melting at 244°. Also those compounds which contain no substituting group in the position 6 in the phenonaphthoxazine molecule pass on warming with dilute acids into the corresponding oxazones containing the oxygen in that position. Thus, Meldola's blue (3-dimethylaminophenonaphthoxazine chloride) passes into 3-dimethylphenonaphthoxazone, melting at 244°, identical with the compound derived from New Methylene-blue GG and New Blue B.

32. "*The Alkylation of* d-*Fructose.*" By Thomas Purdie and David McLaren Paul.

The object of this research was to ascertain if ketoses can be alkylated by the methods already applied to aldoses, and to study the opitical activity of the ketose derivatives thus obtained, Fischer's methylfructoside was methylated by means of methyl iodide and silver oxide. The resultant liquid, which had the composition of tetramethyl methylfructoside, gave on hydrolysis a liquid having the composition of tetramethyl fructose and the properties of a reducing sugar. On realkylation, both by the silver oxide process and by Fischer's method, the substance yielded fully methylated methylfructosides. The rotatory powers of the series of compounds were abnormally low compared with that of the parent sugar. This anomaly, however, was finally explained by the isolation from the syrupy ketose of crystalline tetramethyl-α-fructose (m. p. 98—99°), which showed in alcoholic solution $[\alpha]_D$ 20° $-94{\cdot}2° \rightarrow -86{\cdot}7°$. After fusion, the substance exhibits mutarotation in the opposite sense, owing to partial transformation of the α-sugar into the β-form. This compound gave liquid tetramethyl methylfructosides of high rotatory power. Evidence was obtained that the low rotatory power of the syrupy ketose was probably due to the presence of an isomeric dextrorotatory hexose, produced by isomeric change during the preparation of Fischer's methylfructoside. Evidence was also adduced for the existence of two stereoismeric fructosides in the latter substance.

(To be continued).

PHYSICAL SOCIETY.

Annual General Meeting, February 8th, 1907.

Prof. J. Perry, F.R.S., President, in the Chair.

Report of the Council.

Since the last annual general meeting twelve ordinary science meetings and one informal meeting of the society have been held. Of these, twelve were held at the Royal College of Science, and one, that on March 23rd, was held at University College. The average attendance at the meetings has been 50.

The second annual exhibition of apparatus by manufacturers was held on December 14th, when the attendance of Fellows and visitors amounted to 200.

The number of Fellows now on the roll is 426. Twelve new Fellows have been elected, and two Honorary Fellows, namely, Prof. F. Kohlrausch and Prof. A. A. Michelson. There have been 10 resignations, and the society has to mourn the loss by death of two Honorary Fellows, Prof. S. P. Langley and Prof. Ludwig Boltzmann, and two Fellows, namely, A. G. Bessemer, jun., and Prof. J. Purser.

The council are pleased to report that arrangements have been completed whereby Fellows now have the privilege of obtaining Section A of the Proceedings of the Royal Society at a reduced rate.

Report of the Treasurer for the Year 1906.

The difficulty of collecting arrears of subscriptions, alluded to in the report for 1905, has been severely felt during the past year. The arrears now stand at a higher figure than for some time past. Many correspondents attribute their inability to keep up to date to the long continued prevalence of a high income-tax, which hits many members of our society rather seriously. With this exception the position of the society is fairly prosperous. The value of the invested funds has not appreciably declined, the bank balance shows a substantial increase, and there are no outstanding liabilities.

Election of Officers and Council.

The following Officers and Council were elected for the ensuing year :—

President—Prof. J. Perry, F.R.S.

Vice-Presidents—Those who have filled the Office of President, together with C. Chree, D.Sc., F.R.S.; H. M. Elder, M.A.; Prof. J. A. Fleming, M.A., D.Sc., F.R.S.; and W. Watson, D.Sc., F.R.S.

Secretaries — W. R. Cooper, M.A., and Prof. W. Cassie, M.A.

Foreign Secretary—Prof. S. P. Thompson, D.Sc., F.R.S.

Treasurer—Prof. H. L. Callendar, M.A., F.R.S.

Librarian—W. Watson, D.Sc., F.R.S.

Other Members of Council—T. H. Blakesley, M.A.; A. Campbell, B.A.; W. Duddell; A. Griffiths, D.Sc.; J. A. Harker, D.Sc.; T. Mather, F.R.S.; A. Russell, M.A.; S. Skinner, M.A.; S. W. J. Smith, M.A.; Prof. H. A. Wilson, F.R.S.

Election of Honorary Fellows.

Prof. A. LIPPMANN and Prof. S. NEWCOMB were elected Honorary Fellows of the Society.

The PRESIDENT then delivered an address. He said that many present were aware that in August, 1905, he started a discussion at Johannesburg on the teaching of elementary mechanics. In his reply to that discussion he had tried to make clear his views about engineer's units and centrifugal force. It was time that the schoolmaster should recognise that engineers' units based on the weight of one pound in Londen were as absolute as any other units could possibly be, and when the schoolmaster rejected the term centrifugal force he merely showed that he had done no advance work in kinetics. Centrifugal force was natural and right to any boy, and if his schoolmaster did not teach him through the ideas that he had already, ideas which he found easy to understand, the schoolmaster was doing much worse than showing that he had learned his kinetics altogether from the astronomical side. It was the same with the pound as a unit of force. The ideas that quantity of matter was a simple thing to understand, that quantity of matter and inertia were the same and must be called *mass* were metaphysical, grown up, mixtures of abstractions which were quite unnatural and occult to young students whose experience had been with forces and weights. By simple experiments a young student should be given the fundamental idea that force is (vector) rate of change of momentum and his real knowledge of mathematics would increase greatly. The teaching of mathematics was a subject of enormous interest. Was it possible for any man who had been taught mathematics, and who knew nothing of recent reforms, to believe that the whole system on which he had been taught was quite wrong? Newspaper critics in reviewing his book containing the discussion to which he had referred, had ridiculed his standard boy of 14 who was in the future to know something of the infinitesimal calculus, and they had classed him with Macaulay's fabulous schoolboy. He was glad to say that this standard boy of 14 was a boy of the near future, and that there were some schools in which he was already being developed. It never seemed to occur to the orthodox mathematician that much of the work he tries to give the schoolboy was work that ought not to be touched by a man until after he was a wrangler. In Algebra alone a lot of unnecessary work was done on such subjects as anomalous forms, involution and evolution, surds, roots of a quadratic formation leaning to numerous tricky examples when the straightforward information required might be put in four lines. The same was true of the treatment of imaginary expressions, of ratio and proportion, of scales of notation, and of the progressions and continued fractions. Why was it that the subject of permutations and combinations must precede the binomial theorem? Simply to enable tricky questions to be asked on the binomial. If mathematical gymnastics were wanted they could be obtained in large quantity in the use of the calculus in its interesting applications. The classes in practical mathematics were showing that a board school boy after 50 lessons could use the idea of rate and could differentiate and integrate practically all the functions which were of use in engineering. A standard boy should know decimals at eight, he should use squared paper to record his own experimental results at nine, he should solve interesting problems using squared paper and logarithms and tables of sines and cosines at the age of ten and eleven, and he should get the notion of a rate long before he was twelve. He would have an elementary knowledge of the infinitesimal calculus before he was fourteen. He considered the elementary use of the calculus, and even the solution of easy differential equations, a school and not a university subject. Spherical harmonics and Bessel functions and their use in all sorts of physical problems with actual curve drawing was an undergraduate study. Permutations and combinations and the theory of probability were post-graduate subjects like the study of the fifth book of Euclid.

An Ordinary Meeting of the Society was then held.

Mr. A. RUSSELL read a paper on "*The Magnetic Field and Inductance Coefficients of Circular, Cylindrical, and Helical Currents.*"

The author gives formulæ for the magnetic force near a circular current which can be readily evaluated. He then shows how the self-inductance of a ring of wire and the mutual inductance between two coaxial circular filaments can be found without using Neumann's theorem. By Kelvin's method, the results obtained can be applied at once to the corresponding problem of the simple vortex filament in hydrodynamics, In this way expressions are found for the velocity of translation of a circular vortex filament—about which there appears to be uncertainty in hydrodynamical theory—and for the energy of the motion. The exact formula for the mutual inductance between a cylindrical current sheet and a coaxial helical filament of current is obtained. It is expressed both in terms of elliptic integrals and in the form of an algebraical series. In the latter case it can be readily computed in important practical cases, as, for instance, in the case of the mutual inductance standards used to calibrate the galvanometers used in iron testing. The helical coils can be made of the same axial length and the pitch of only one of them need be small. Thus very compact standards can be constructed. It is shown that Lorenz's formula for self-inductance is a particular case of the author's formula for mutual inductance, and that a well-known formula due to Lord Rayleigh is a particular case of Lorenz's formula.

When the length of the helix is greater than twice its diameter and the pitch of the helix is small the self-inductance L is given by—

$$L = 2\pi(a^2/h)N^2[1 - 4a/3\pi h + a^2/8h^2 - a^4/64h^4];$$

where N is the number of turns, $2a$ the diameter, and $2h$ the axial length. The maximum inaccuracy of this formula, as compared with the more accurate elliptic integral formula, is less than 1 in 8000. The author has found this formula useful in practical work.

Mr. A. Campbell said the accurate calculation of mutual inductances was of great practical importance because it formed the basis of several of the chief methods of determining the absolute electrical units: it was therefore highly satisfactory that Mr. Russell had succeeded in obtaining the complete solution for the most general case required. The author's series solution (41) was a most interesting one, When the length of one of the coils was very small compared with that of the other the series became practically o/o. This was the case used by Prof. Jones. Mr. Campbell suggested that from the author's series formula a suitable series might be obtained by differentiating with regard to h_2 (omitting the h_2 in the denominator). In calculating mutual inductance by Mr. Russell's complete formula (38) or by that of Prof. Viriamu Jones, it was necessary to find the incomplete integrals E (c, ϕ) and F (c, ϕ). These could often be found to a high degree of accuracy by the following two formulæ due to Legendre, viz.—

$$E(c, \phi) = \frac{1}{c}\sin c\phi + \frac{l^2c^2}{30}\phi^5 - \frac{l^2c^2}{1260}\phi^7(4 - 11c^2),$$

and—

$$F(c, \phi) = \frac{1}{c}\log_e\left(\frac{\pi}{4} + \frac{c\phi}{2}\right) - \frac{l^2c^2}{30}\phi^5 + \frac{l^2c^2}{1260}\phi^7(4 - 41c^2);$$

where $l^2 = 1 - c^2$. The first formula is accurate to 7 decimal places if $\phi < 30°$ and the second to a similar accuracy if $\phi < 20°$ or if ϕ 30° when $c <$ sin 35° or $>$ sin 75°.

Mr. A. Russell in reply, after thanking Mr. Campbell for his remarks, called attention to the important relations between the equations of vorticity in hydrodynamics and the equations of electro-dynamics. He had experienced difficulty in conceiving the nature of the stress in the medium surrounding an electric current. Was the energy stored in the medium when a current was flowing kinetic or potential? Some physicists spoke as if the state of stress in the medium was due to streams of ether whirling round the electric current; others, that it was due to a compression of the medium.

NOTICES OF BOOKS.

Science and Agriculture in 1906. By Sir James Blyth, Bart.

This brief review has to chronicle many notable advances in the task of inducing the practical agriculturist to recognise the value of the applications of scientific methods to the problems he has to face, although there still remains much to be done in this direction. Some of the most important developments during the year 1906 include the discoveries made by the Agricultural Department of the University of Cambridge relating to the hybridisation and improvement of wheat, which has been the subject of research for some years past, although no very definite results have been obtained until quite recently. Important experiments have also been made at Rothamsted and other places on the use of artificial fertilisers, and the year has seen some valuable discoveries in connection with the prevention and cure of plant diseases. The pamphlet contains some suggestions which, if adopted, might extend the usefulness of the Board of Agriculture, and give a great impetus to the agricultural industry in England.

Painters' Colours, Oils, and Varnishes. By George H. Hurst, F.C.S. Fourth Edition. London: Charles Griffin and Co., Ltd. 1906.

The latest edition of this work contains, among other additions, descriptions of new processes for preparing white-lead which are now coming into use, and the chapter on lakes has been much enlarged. While the book is not a laboratory guide, the practice of the manufacture of paints and their analysis is fully treated, and the theory underlying the most familiar methods is carefully explained, so that the reader should easily acquire an intelligent grasp of the main principles involved. The book is one which can be thoroughly recommended for the use of technical students, and the fourth edition is an excellent example of an up-to-date practical treatise, in which all branches of the manufacture and assay of pigments, paint, vehicles, driers, and varnishes are discussed at considerable length.

Lehrbuch der Allgemeinen, Physikalischen, und Theoretischen Chemie. ("Text Book of General, Physical, and Theoretical Chemistry"). By F. W. Küster. Parts I.—IV. Heidelberg: Carl Winter, 1906.

This treatise on general chemistry forms part of the new edition of Gmelin and Kraut's "Text Book of Inorganic Chemistry," now being published. The author has endeavoured to present the subject as simply as possible, without sacrificing completeness, believing that most theoretical books are far too difficult, and make unnecessarily large demands upon the student's previous knowledge. He has certainly produced a very readable text-book, and one which is more especially suitable for those who are looking forward to a career connected with some technical branch of chemistry, or for botanists or doctors who require some knowledge of chemical theory for special purposes, but who are hampered by the insufficiency of their acquaintance with mathematics—for many a serious drawback in the study of physical chemistry. The amount of theoretical knowledge, without which even elementary students now find themselves ill-equipped, is rapidly and constantly increasing, and at present there is undoubtedly some difficulty in finding a suitable work. This the author of the present treatise seems likely to provide, judging from these first parts, which are clearly written, and contain a specially lucid treatment of some points, often found rather difficult to grasp, such as the Phase Rule.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 5, February 4, 1907.

The Ethyl Ether-oxide of α₁-Dichlorisopropylic Alcohol, and Dibromacetic Aldehyde.—P. Freundler.—In consequence of a recent publication of a research upon dichloracetic aldehyde and the αα-dichlorisopropyl alcohol, the author describes some experiments of the same order, carried out by him with the object of obtaining lactic aldehyde. 1. He found that condensation of dibromacetic aldehyde with methyl magnesium iodide gave rise to αα-dibromisopropyl alcohol, a far less stable body than the dichlor alcohol, partially decomposing on distillation. 2. Another body investigated was the ethyl ether-oxide of αα-dichlorisopropyl alcohol, $CH_3.CH(OC_2H_5).Cl_2$, which forms as an accessory product in the preparation of trichlorobutyric acetal. The attempt to transform it into

ethyl lactic aldehyde, by heating it in a closed vessel with lead oxide and water, did not succeed. 3. In the study of dibromacetic aldehyde are mentioned the reactions with phenyl hydrazine and semicarbazide, which produce corresponding derivatives of glyoxal.

Certain Reactions of Sodium Amide.—Louis Meunier and E. Desparmet.—To the already large collection of researches in organic chemistry, in connection with the use of sodium amide, the authors add the following:—1. The action of sodium amide upon certain polyhalogen derivatives of the carbides. 2. The use of sodium amide as a substitute for the ethylate in obtaining sodium derivatives. 3. The action of sodium amide upon the aldehydes. I. (*a*) The action of ethylene dibromide upon sodium amide produces acetylene,—

$$CH_2Br—CH_2Br+2NH_2Na=CH\equiv CH+2NaBr+2NH_3.$$

(*b*) The action of chloroform upon sodium amide—by dropping the latter in minute quantities in the powdered state into excess of chloroform to avoid explosion—produces sodium cyamide,—

$$CHCl_3+4NH_2Na=CNNa+3NaCl+3NH_3;$$

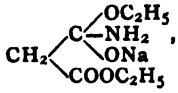
if the equation be written thus—

$$NH_2Na+CHCl_3+3NH_2Na=CNNa+3NaCl+3NH_3$$

it is seen to be identical with that which occurs in the preparation of the carbylamines,—

$$NH_2R+CHCl_3+3KOH=CNR+3KCl+3H_2O.$$

II. (*a*) As an example of the sodium derivatives of the primary and secondary amines, diphenylbenzylamine, $(C_6H_5)_2N—CH_2—C_6H_5$, was prepared by adding diphenylamine, drop by drop, to a slight excess of sodium amide, in an ether solution of benzyl chloride. (*b*) Diazo-amide sodium derivatives. If sodium amide reacts with an ether solution of diazoamidobenzene, the sodium derivative of formula $C_6H_5—N=N—\underset{\displaystyle Na}{\underset{|}{N}}—C_6H_5$ is obtained. (*c*) Sodium derivatives of ethyl malonate. One molecule of sodium amide reacting with one molecule of ethyl malonate, in anhydrous benzene solution, produces in the cold a transparent gelatinous body, with the probable formula—



which, heated on the water-bath, evolves ammonia, and is converted into the liquid sodium derivative $CHNa<^{COOC_2H_5}_{COOC_2H_5}$, and this, when heated with one molecule of ethyl iodide, produces ethyl ethyl-malonate with precipitation of sodium iodide. III. When anhydrous ethyl aldehyde is allowed to fall drop by drop upon sodium amide, a white crystalline precipitate is obtained with evolution of ammonia. This can only be explained by the following equation:—

$$CH_3—COH+2NH_2Na=CH_3—CH=NNa+NaOH+NH_3.$$

The crystalline deposit probably consists of a mixture of aldehydate and imine of sodium.

MISCELLANEOUS.

Death of Henri Moissan.—We have just received information of the death of the eminent French chemist Henri Moissan, whose researches on the artificial production of diamonds and the electric furnace are familiar to our readers. We hope to give an obituary notice in our next issue.

Royal Institution.—On Thursday next, February 28th, at 3 o'clock, Dr. W. Martin begins a course of two lectures at the Royal Institution on "Old Dutch Paintings and Painters." The Friday Evening Discourse on March 1st will be delivered by Count de Bosdari on "Dante in the Critical and Poetical Works of Carducci," and on March 8th by Professor David James Hamilton on "Certain Seasonal Diseases in the Sheep and the Means of Preventing them."

South-Western Polytechnic, Chelsea.—The Lord Alverstone, G.C.M.G., Lord Chief Justice of England, presents Prizes and Certificates to Students of Evening Classes and Day College on March 15th, at 8 o'clock, p.m.

Merchant Venturers' Technical College.—There were 58 candidates for the post of Assistant Professor of Chemistry in the Merchant Venturers' Technical College, which has been vacated by Professor G. P. Darnell-Smith on his appointment as Assistant Director of Technical Education to the Board of Education, Auckland, New Zealand. Dr. F. W. Rixon has been selected from among these candidates. He had a distinguished career in the Victoria University of Manchester, which he entered with a Lancashire County Council Scholarship in 1896, and where he took the Degree of B.Sc. with First-class Honours in Chemistry in 1899, proceeding to the M.Sc. Degree in 1902. In 1900 he was elected to a Fellowship in the University, and in 1901 he was awarded an 1851 Exhibition Scholarship, which enabled him to continue his studies at the Uuiversity of Giessen, where in 1903 he obtained his Ph.D. Degree. It will be seen that he has spent seven years as a University student of Chemistry and the allied Sciences; during the last four of these years he was engaged in original research work and published papers on questions dealing with various branches of Chemistry. Since 1903, Dr. Rixon has held the post of Science Instructor to the Devonshire County Council.

MEETINGS FOR THE WEEK.

Monday, 25th.—Society of Arts, 8. (Cantor Lectures). "Romanesque Ornament," by F. Hamilton Jackson.

Tuesday, 26th.—Royal Institution, 3. "The Visual Apparatus of Man and Animals," by Prof. William Stirling.

Wednesday, 27th.—Society of Arts, 8. "Modern Typewriters and Accessories," by Arthur E. Morton.

Thursday, 28th.—Royal Institution, 3. "Old Dutch Painting and Painters," by Dr. W. Martin.

Friday, March 1st.—Royal Institution, 9. "Dante in the Critical and Poetical Works of Carducci," by Count de Bosdari.

Saturday, 2nd.—Royal Institution, 3. "Röntgen, Cathode, and Positive Rays," by Prof. J. J. Thomson.

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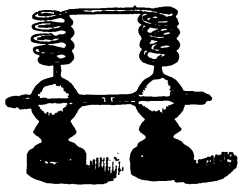

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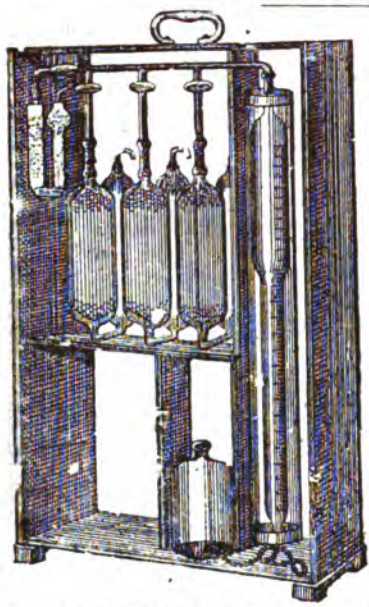

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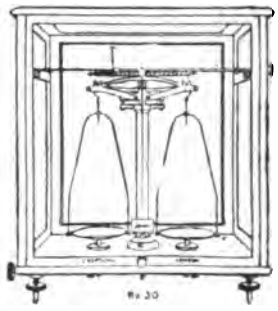

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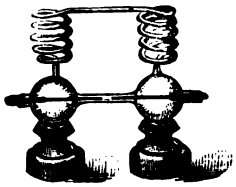

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ON A NEW IRON CARBONYL, AND ON THE ACTION OF LIGHT AND OF HEAT ON THE IRON CARBONYLS.*

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THIS paper contains an account of the results of the continuation of the experiments on the action of light on the liquid iron carbonyl (iron pentacarbonyl) and the action of heat on the resulting solid compound, diferro-nonacarbonyl, $Fe_2(CO)_9$, which were described in a paper on "The Physical and Chemical Properties of Iron Carbonyl," communicated to the Royal Society in 1905 (*Proc. Roy. Soc.*, A, 1905, lxxvi., p. 558).

The experiments on the action of light on iron pentacarbonyl under varied conditions have resulted in new and interesting observations, and approximate measurements of the velocity of the reaction induced by light have been made and compared with that of other reactions induced by light.

The action of heat on solid iron carbonyl, which we described in our former communication as producing an intense green colour, which colour Dr. Mond stated that he had observed casually, has been further examined, and the experiments now described have led to the discovery of a new compound of iron and carbon monoxide, iron tetracarbonyl, which forms dark green crystals of remarkable stability, exhibiting some very striking properties.

Action of Light on Iron Pentacarbonyl.

It was shown in the former communication that the action of light on iron pentacarbonyl alone or in solution in solvents, with the exception of nickel carbonyl, is represented by the equation $2Fe(CO)_5 = Fe_2(CO)_9 + CO$.

Carbon monoxide is evolved and diferro-nonacarbonyl, an orange-red crystalline compound, is produced and separates out. When pyridine was used as solvent, the diferro-nonacarbonyl remained in the deep red solution unless very much iron pentacarbonyl had been used, when some crystals were deposited.

The fact that solid is not deposited from a pyridin solution of iron pentacarbonyl under the action of light is attributed to the solubility of the diferro-nonacarbonyl in pyridine, since it was shown that solid was deposited when the solution contained more than 50 per cent of the pentacarbonyl (*loc. cit.*, p. 575). This has been confirmed by using a saturated solution of the diferro-nonacarbonyl in pyridine as solvent for the pentacarbonyl. A 20 per cent solution of iron pentacarbonyl in this mixture, on exposure to light for a long time deposited crystals. Owing to the deep colour of the solution, the action is naturally a very slow one. A 20 per cent solution of iron pentacarbonyl in pyridine alone would not have deposited any of the solid.

When nickel carbonyl was used as solvent no change occurred; the solutions were of a much paler colour than solutions of the same concentration in other solvents, and it was suggested that the two carbonyls united to form an unstable compound $\{Fe(CO)_5Ni(CO)_4\}$ which was analogous to $Fe_2(CO)_9$ and was unaffected by light.

Also it was shown that above 60° C. light had no apparent action on solutions of iron pentacarbonyl, and that the reaction induced by light was reversed in the dark.

* A Paper read before the Royal Society, January 24, 1907.

The later experiments were directed towards confirming and extending the above observations.

Action of Light on Iron Pentacarbonyl at Higher Temperatures.

In the former communication (p. 574) it was stated that if iron pentacarbonyl or its solutions in ether or petroleum ether were heated to any temperature between 60° and 100° C. while exposed to light, then no separation of solid occurred, even after long exposure and subsequent cooling in the dark.

This remarkable behaviour has been further confirmed by exposing tubes to light while immersed in the vapours of various liquids and observing whether solid was deposited or not, while hot or after cooling in the dark, and also by using tubes provided with a manometer of the type used for the velocity measurements described below. Usually, petroleum ether solutions, containing about 10 per cent by volume of iron pentacarbonyl, were used; ether solutions were also used.

In ether vapour, 30° to 35° C., solid is slowly deposited, and the manometer shows an increase of pressure. On bright days, an appreciable amount of solid had formed after five minutes.

In the vapour of petroleum ether, 45° to 50° C., the solid was more slowly formed, but in half-an-hour on the same day a distinct amount of crystalline deposit had formed, and the manometer again indicated an increase of pressure.

In acetone vapour, 56° C., no solid was deposited after exposure for five hours to bright sunlight, no increase of pressure was noticed, and no solid was deposited when the tube was allowed to cool in the dark.

In chloroform vapour, 61° C., no change was observed after six hours' exposure to bright sunlight, no solid separated when the tube was cooled in the dark, and the manometer showed that no increase of pressure had occurred.

That the deposition of solid is a delicate and trustworthy indication of any change is proved by the fact that whenever any solid could be observed the manometer indicated an increase of pressure. The solid is extremely sparingly soluble in the two solvents, petroleum ether and ether, and so is deposited as soon as formed. Further, above 46° C., the solid is gradually decomposed, as will be described later, producing a green solution; no trace of this colour was ever observed in the tubes exposed to light at any temperature between 50° and 100° C., provided they contained no solid before they were heated. An experiment was made in which a solution of iron pentacarbonyl containing a little of the solid diferro-nonacarbonyl was heated to 56° C. and then exposed to light. A green colour was produced, but no solid was deposited after several hours.

It is noteworthy that neither on bright days in December nor in July could we observe any decomposition at temperatures about 56° C.; that is, no definite shifting of the transition temperature due to the difference in the intensity of the light could be observed.

These experiments will be discussed later, when the experiments on the reverse reaction have been described.

Approximate measurements of the velocity of the reaction were made in solutions in petroleum ether and in pyridine at two concentrations, and the rate in the two solvents compared. Since no artificial light had been found to effect the change at all rapidly, it was necessary to depend on sunlight, the intensity of which naturally varied considerably. Tubes of the same size were made to hold the solutions, and these were filled with solutions of arbitrary concentrations which were in the ratio of 2 to 1, so that information as to the "order" of the reaction might be obtained. These tubes were sealed on to a capillary tube, closed at the other end and containing a small pellet of mercury; measurements of the movement of this mercury index enabled us to determine the pressure inside the tubes. The tubes were set side by side in a glass tank of water, and exposed to direct sunlight and

examined at intervals until no further change took place. Calculation of the fraction of the whole decomposed x/a, where a represents the final increase of pressure and is a measure of the initial concentration of the iron carbonyl, and x is the increase of pressure at any time and is a measure of the amount of decomposition that has taken place, shows clearly that the reaction proceeds as one of the "first order," since it will be seen that the fraction for each concentration is the same within as narrow limits as could be expected in the circumstances. The agreement is naturally not good at the beginning, since the solution must became saturated with the gas. It is probable that great supersaturation is prevented in the case of petroleum ether by the separation of solid; but in the case of pyridine, where no solid separates, this disturbing effect, which tends to make x/a too small at the beginning, is much greater, and good agreement is only obtained near the end of the reaction.

Another fact must also be taken into consideration as affecting the result: in the case of petroleum ether more solid separates from the more concentrated solution than from the other; in the case of pyridine it acquires a deeper colour, so that in both cases less light penetrates the more concentrated solution; in both cases, therefore, the amount of change is relatively less in the more concentrated solution towards the end. This is shown by the greater values of x/a for the dilute solution near the end.

The following two sets of experiments are sufficient to indicate the kind of result obtained:—

I.—*Solvent: Petroleum Ether.*

Time.	A. Concentration 2.		B. Concentration 1.	
	Pressure. Atmos.	x/a.	Pressure. Atmos.	x/a.
2 mins.	1·01	0·001	1·02	0·004
12 ,,	1·30	0·033	1·07	0·014
22 ,,	1·72	0·079	1·30	0·060
32 ,,	2·25	0·147	1·47	0·094
42 ,,	2·46	0·16	1·81	0·16
55 ,,	2·70	0·19	2·05	0·21
112 ,,	3·86	0·32	2·69	0·34
142 ,,	4·26	0·36	2·80	0·36
182 ,,	4·76	0·41	3·25	0·45
247 ,,	5·40	0·47	3·55	0·51
28 hours	7·36	0·70	4·33	0·67
2 days	8·1	0·78	5·2	0·84
∞	10·1	1·0	6·0	1·0

II.—*Solvent:* C *and* D, *Pyridine;* E, *Petroleum Ether.*

Time.	C. Conc. 2.		D. Conc. 1.		E. Conc. 2.	
	Pressure. Atmos.	x/a.	Pressure. Atmos.	x/a.	Pressure. Atmos.	x/a.
5 mins.	1·00	—	1·00	—	1·03	0·014
7 ,,	1·00	—	1·00	—	1·10	0·014
10 ,,	1·03	—	1·01	—	1·17	0·023
20 ,,	1·13	—	1·02	—	1·25	0·034
30 ,,	1·16	—	1·03	—	1·47	0·064
50 ,,	1·31	—	1·06	—	1·92	0·126
70 ,,	1·49	—	1·12	—	2·80	0·24
85 ,,	1·60	—	1·24	—	3·02	0·27
105 ,,	1·67	0·13	1·33	0·093	3·13	0·28
135 ,,	1·81	0·15	1·46	0·13	3·57	0·35
175 ,,	2·47	0·28	2·21	0·34	4·41	0·47
255 ,,	3·18	0·43	2·43	0·40	5·00	0·55
325 ,,	3·35	0·46	2·70	0·48	5·30	0·58
26 hours	4·78	0·76	3·47	0·70	5·78	0·65
52 ,,	5·12	0·81	4·07	0·86	6·83	0·80
∞	6·09	1·00	4·56	1·00	8·35	1·00

A tube set up in precisely the same way with nickel carbonyl as solvent showed during several months' exposure only very slight changes of pressure, which were due to temperature changes.

In order to compare the decomposition of iron carbonyl with other reactions induced by light, we compared the rate of evolution of gas from a solution of iron pentacarbonyl in petroleum ether with that from a solution of ferric chloride and oxalic acid. The latter action, which has been examined by Lemoine (*Ann. de Chimie et de Phys.*, 1895, [7], vi., p. 433), proceeds according to the equation $2FeCl_3+H_2C_2O_4=2FeCl_2+2HCl+2CO_2$, is exothermic, and at the ordinary temperature only takes place under the influence of light.

For the purpose of the approximate comparison, equimolecular solutions of iron pentacarbonyl in petroleum ether and of ferric chloride were used. In order to make the latter reaction approximate more nearly to a reaction of the "first order," two molecular proportions of oxalic acid were used (more cannot be added, since the solution then changes its colour and ferrous oxalate is deposited during the later stages).

Both solutions are yellow, but the colour of ferric salt solution is much deeper than that of the iron carbonyl at the same molecular concentration; hence the comparison is not quite fair, since the amount of change is proportional to the light absorbed, and the latter solution absorbs more light.

Two solutions were used, containing respectively 4 per cent and 10 per cent of iron carbonyl, and the rate of change compared with two ferric chloride and oxalic acid solutions of corresponding equimolecular concentrations.

The solutions were placed in tubes of the same size, which were placed side by side in a tank of water, and the gases evolved were collected over glycerin.

The volume of gas evolved from the ferric salt solutions is twice that evolved from the corresponding iron carbonyl solutions.

The ferric salt solutions were saturated with carbon dioxide before being introduced into the tubes, yet it is probable that the supersaturation of the solution which is set up causes a lag in the evolution of gas at the beginning. Later, the deposition of solid from the iron carbonyl solutions cuts off some of the light and further diminishes the rate of this action as compared with the other.

The results of six sets of experiments show that there is no very pronounced difference in the sensibility to light of the two reactions in the more concentrated solutions, but that in the more dilute solutions the ferric chloride and oxalic acid mixture is the more sensitive.

The following table gives the fractions of the total amount of gas evolved from the solutions during the same time:—

$Fe(CO)_5$, 10 per cent.	Fe, 2·86 per cent. $H_2C_2O_4$, 4·6 per cent.	$Fe(CO)_5$, 4 per cent.	Fe, 1·12 per cent. $H_2C_2O_4$, 2·86 per cent.
0·24	0·19	0·12	0·28
0·28	0·25	0·26	0·40
0·31	0·37	0·40	0·67
0·40	0·55	0·65	0·85
0·66	0·75	0·75	0·95
0·71	0·79		
0·82	0·94		

The figures for the dilute solutions do not represent readings taken at the same time as those for the more concentrated solutions.

From the above numbers no very definite conclusions can be drawn, but it is probable that iron carbonyl is more sensitive to light than the ferric chloride oxalic mixture, seeing that the decomposition is nearly as rapid in the former case as in the latter, and the amount of light absorbed by the ferric chloride and oxalic acid mixture is greater than that absorbed by the iron carbonyl solutions.

A rough comparison of the velocity of the decomposition of iron carbonyl with that of the reaction between mercuric chloride and oxalic acid, which was measured by the development of pressure due to the carbon dioxide, showed that the former reaction proceeded very much more rapidly than the latter under the same conditions.

Reversal of the Reaction.

The velocity of the reverse reaction,—

$$Fe_2(CO)_9 + CO = 2Fe(CO_5),$$

which proceeds in the dark, was studied by using the same tubes that were used for the examination of the direct action. The results show that this is an extremely slow reaction at the ordinary temperature. Tube E, above, containing petroleum ether, had a pressure of 3 atmospheres after three months, so that only 73 per cent of the gas had been re-absorbed by the solid; after eleven months the pressure was still 1·68 atmospheres, so that 92 per cent of the products had re-combined.

With pyridine as solvent the reverse action was more rapid at the beginning, but did not proceed so far. Thus, after fifteen days in the dark, tube D, containing pyridine, had a pressure of 1·8 atmospheres, representing 51 per cent recombination, while in the petroleum ether tube E only 28 per cent recombination had occurred at the same time.

The two tubes, A and B, containing petroleum ether, were used for studying the rate of the reverse reaction at higher temperatures. B was heated in ether vapour. In two days the pressure fell from 6 to 4·1 atmospheres, in five days to 2·8 atmospheres, in ten days to 1·6 atmospheres, and after sixteen days the reversal was complete, the solid had disappeared, and the pressure had fallen to 1 atmosphere. Similar results were obtained with other tubes. Attempts were made to study the reverse reaction at higher temperatures; in carbon disulphide vapour (46° C.) the reaction appeared to proceed more rapidly, but development of a green colour showed that already the decomposition of the diferro-nonacarbonyl by heat was beginning, and this naturally vitiated the results.

Results of precisely the same kind were obtained with methylal as solvent. The solid diferro-nonacarbonyl is slightly soluble in the solvent, and on heating gives a red solution—it is therefore intermediate in its behaviour between petroleum ether and pyridine; as in the case of pyridine the reverse action is also more rapid in the early stages than it is in ether or petroleum ether.

These observations on the greatly increased velocity of the reaction between diferro-nonacarbonyl and carbon monoxide at temperatures little above the ordinary temperature are of great importance in their bearing on the absence of any action of light on iron pentacarbonyl above 56° C.

Iron carbonyl shows no selective absorption, but completely absorbs the more refrangible rays.

It was found by spectroscopic examination of iron carbonyl and its solutions that there was no observable difference in the amount of light absorbed at 15° C., and at 60° or 100° C.

The absence of action of light above 56° C. must be due, therefore, either to a greater stability of the iron pentacarbonyl molecule at higher temperatures or to the displacement of an equilibrium represented by the equation $2Fe(CO)_5 \rightleftarrows Fe_2(CO)_9 + CO$, in the direction of the liquid carbonyl at the higher temperatures. The fact that the action of carbon monoxide on the diferro-nonacarbonyl is so much accelerated by an increase of temperature makes it probable that this is the true explanation. Lemoine (*loc. cit.*) has shown that the reaction between ferric chloride and oxalic acid exhibits no appreciable acceleration due to increase of temperature; the action of light on the silver halides is also little affected by temperature. If the decomposition of iron pentacarbonyl also has no temperature coefficient, which is not improbable, since we were able to observe the action at −180° C., and the reverse action has the normal temperature coefficient of chemical reactions, then the absence of any change at temperatures above 56° C. is easily explained.

This explanation is compatible with the assumption that the decomposition of the pentacarbonyl by light is an exothermic change, so that the reverse reaction must take place with absorption of heat, and an increase of temperature would favour the progress of the endothermic change, *i.e.*, the recombination of carbon monoxide and the diferro-nonacarbonyl.

We are continuing the experiments on these and other chemical reactions induced by light, and applying other methods in studying them, the results of which we hope to describe later.

(To be continued).

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 90.

Part I.—Preparation of the Solution.

General Discussion.

The attempt has been made to devise a systematic method of preparing the solution of the substance for analysis, which shall be uniform for all substances, which in the case of those ordinarily met with shall be as rapid as possible, and which shall be so complete as to effect the solution of substantially all known substances. Heretofore little attention has been given to the development of such a definite, uniform plan of treatment, it being assumed that the analyst has the experience necessary to enable him to select, on the basis of the known general character of the substance or of a series of preliminary tests in the dry way, the most suitable method to employ for its decomposition. Yet more experience is required for this than for the ordinary group separations; and there seems to be no reason whatever why this important and difficult part of the analytical process should not be treated in the same systematic way as are the separations and tests for the various elements.

The general character of the plan here presented for accomplishing this end will be readily seen from the "Tabular Outline" given below. The only preliminary test required is one for the presence of organic matter and water, which is made by heating the substance in a closed tube; thus are eliminated the time-consuming blowpipe tests usually recommended, the success of which can be assured and the true significance interpreted only after much experience. For substances found to contain organic matter a special treatment with nitric and sulphuric acids is described by which the organic matter is destroyed. Other substances are treated first with water, and, if this does not cause complete solution, immediately after with fairly strong nitric acid; and any residue still remaining is boiled with hydrochloric acid and aqua regia, in order to remove a few substances, such as manganese and lead peroxides, mercuric sulphide, gold, and platinum, which are attacked by these acids, but not by nitric acid.

In the treatment of the residue that may remain unattacked by these acids lies the main difference between our process and that ordinarily recommended in text-books on qualitative analysis; for, as shown in Table II., any such residue is heated with sulphuric and hydrofluoric acids instead of being fused with an alkaline carbonate. By this modification the process of preparing the solution is much simplified in the great majority of cases; for silica is thereby detected and eliminated at the start, and almost all silicates are decomposed, yielding at once either a complete solution, or, if lead, barium. strontium, or much calcium is still present, a residue of their sulphates which can readily be decomposed by boiling with sodium carbonate solution. An even more important advantage of this method, however, is that no foreign metallic elements are introduced; while, when a fusion is made, alkali

* From the *Technology Quarterly*, xix., No. 3, September, 1906.

TABLE I.

Determine by preliminary tests whether the substance contains organic matter (P. 1); and, if not, whether it dissolves completely in water and forms an acid or neutral solution (P. 3).

<table>
<tr>
<td colspan="3">Substances containing Organic Matter.—Heat with H_2SO_4 and HNO_3 to destroy organic matter, evaporate off HNO_3, add water (P. 2).</td>
<td colspan="2">Substances Soluble in Water forming a Neutral or Acid Solution.—Dissolve in water, add HCl (P. 11).</td>
<td colspan="3">Other Substances.—Heat with HNO_3, evaporate, dry, add dilute HNO_3 (P. 3).</td>
</tr>
<tr>
<td rowspan="2">Residue.
See Table II. or III. below.</td>
<td colspan="2">Solution.—Add HCl (P. 2).</td>
<td rowspan="2">Precipitate.
AgCl, HgCl, [$PbCl_2$], [TlCl]. (P. 12).</td>
<td rowspan="2">Filtrate.
All elements except Ag. Pass in H_2S (P. 21).</td>
<td colspan="2">Solution.—Add HCl (P. 3).</td>
<td rowspan="2">Residue.—A (from alloys.—Sb_2O_5, SnO_2, [P_2O_5], [As_2O_5], SiO_2, [TiO_2], WO_3, C, Au, Pt, Ir, &c.; some iron alloys.
B (from other substances).—Oxides under A above and substances under B in Table II.; also MnO_2, PbO_2, and HgS.
Heat with HCl and HCl + HNO_3, evaporate, dry, add dilute HCl (P. 4).</td>
</tr>
<tr>
<td>Precipitate.
AgCl. Confirm by P. 15.</td>
<td>Filtrate.
All elements except Ag, Cr, Pb, Ba, Sr. Pass in H_2S (P. 21).</td>
<td>Precipitate.
AgCl, [$PbCl_2$], [TlCl] (P. 12).</td>
<td>Filtrate.
Evaporate; add HCl (P. 4).</td>
</tr>
<tr>
<td colspan="5"></td>
<td>Solution.—All elements except Ag. Pass in H_2S (P. 21).</td>
<td>Residue.—See Table II. or III. below.</td>
</tr>
</table>

TABLE II.

Residue Undissolved by Acids from Table I.

A. *From Alloys.*—[SnO_2], SiO_2, TiO_2, WO_3. (C, Ir, &c., some Fe alloys). NOTE.—A *metallic* residue obtained from an alloy is not treated as described in the table, but is best fused with Na_2O_2 (P. 4, N. 2).

B. *From Non-metallic Substances.*—Oxides under A; also AgCl, CaF_2, MoS_2, many silicates, the sulphates of Pb, Ba, Sr, native Al_2O_3, $FeO.Cr_2O_3$.

C. *From Substances containing Organic Matter.*—Substances under B (except CaF_2); also Sb_2O_5, $BiOSO_4$, $Cr_2(SO_4)_3$, $CaSO_4$.

Heat with H_2SO_4 and HF, evaporate to expel HF, dilute, boil (P. 5).

<table>
<tr>
<td rowspan="4">Gas.
SiF_4.
Presence of silicon.</td>
<td rowspan="4">Solution.
All elements except Pb, Ba, Sr. Pass in H_2S (P. 21).</td>
<td colspan="3">Residue.—Pb, Ba, Sr, [Ca,], [B:], [Cr], as sulphates; Sb_2O_5, WO_3; native SnO_2, Al_2O_3, TiO_2, $FeO.Cr_2O_3$; some silicates. Boil with Na_2CO_3 solution (P. 6).</td>
</tr>
<tr>
<td>Solution.
Na_2WO_4. Test for tungsten (*P. 6a).</td>
<td colspan="2">Residue.—Pb, Bi, [Ba], Sr, Ca, as carbonate; [$BaSO_4$], other substances, except WO_3, as above. Heat with HCl (P. 6).</td>
</tr>
<tr>
<td></td>
<td>Solution.
Pb, Bi, Sb, Cr, [Ba], Sr, Ca, as chlorides. Pass in H_2S (P. 21).</td>
<td>Residue.—[$Cr_2(SO_4)_3$], [$BaSO_4$], MoS_2, native oxides and silicates as above. Fuse with Na_2CO_3 and KNO_3, add HCl, evaporate, add dilute HCl (P. 7).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solution.
Test for all elements except alkalis (P. 21).</td>
<td>Residue.—SiO_2; native SnO_2, TiO_2, Al_2O_3. Remove SiO_2 with HF; fuse residue with KOH (P. 7, N. 3).</td>
</tr>
</table>

TABLE III.

(Alternative Process).

Residue Undissolved by Acids from Table I.

Composition: See Heading of Table II.

Fuse with Na_2CO_3 and K_2CO_3 in a porcelain crucible, adding KNO_3 if necessary; add water, filter (P. 8).

Solution.—Sodium and potassium silicate, stannate, antimonate, arsenate, aluminate, chromate, manganate, tungstate, molybdate, sulphate, and carbonate. Acidify, evaporate, dry, add dilute HCl (P. 8).		*Residue.*—Almost any metallic element as metal, oxide or carbonate. Add HNO_3 (P. 8).
Solution.—Sn, Sb, As, Mo, Al, Cr, as chlorides. Pass in H_2S (P. 21).	*Residue.*—SiO_2, WO_3. Reject, or treat by P. 5 and *6a.	*Solution.*—Almost any element as nitrate. Add HCl (P. 8).
Filtrate.—Evaporate, add HCl, test for all elements except alkalis (P. 21).	*Precipitate.*—AgCl, [$PbCl_2$] (P. 12).	*Residue.*—Native SnO_2, TiO_2, Al_2O_3. Fuse with KOH, add water and HCl (P. 7, N. 3), test solution for Sn, Al, Ti.

elements are introduced from the flux, and aluminium, calcium, and silica from the porcelain crucible, which ordinarily must be used, owing to the possible presence of reducible metallic elements, thus making it necessary to employ other special methods for the detection of these elements. Objection may be raised to the use of hydrofluoric acid because of its being an expensive and irritating reagent, and because it must be handled in platinum vessels, thus making it hardly practicable for the use of large classes of beginners in the subject. Realising the force of the last consideration, we have described (as indicated in Table III.) the usual method of fusion with an alkaline carbonate as an alternative procedure, which may be used under circumstances which do not permit of the simpler and more satisfactory method with hydrofluoric acid. But in doing so we wish to express the conviction that when the subject of qualitative analysis is studied as a branch of analytical chemistry, and not merely as a means of imparting a certain additional chemical knowledge, it ought to be pursued under the same conditions with respect to accuracy of manipulation and availability of facilities as is customary in courses upon quantitative analysis. For the inability to make a good qualitative analysis is a common source of error in quantitative analytical results; and lack of thoroughness in the instruction in qualitative analysis often develops careless and inaccurate habits of work. We have therefore aimed to develop the scheme of analysis best adapted to the purposes of the analyst, and have not hesitated to avail ourselves of the special methods and reagents commonly used only in quantitative work when a more reliable or simpler process could thereby be developed.

Only few substances, especially a few silicates and native oxides, fail to be dissolved by the treatment with sulphuric and hydrofluoric acids; and it is very rare that any further operations are necessary. But to provide for these special cases it is directed to fuse any residue with alkaline carbonate and nitrate, which can now safely be done in a platinum crucible; and, finally, to fuse any residue still remaining (which is likely to consist only of aluminium, tin, or titanium oxide) with potassium hydroxide.

Tabular Outline.

In the "Tabular Outlines" the enclosure of a symbol in brackets shows that the element may divide itself between the residue and solution in the operation immediately preceding. The symbols of the anhydrous substances are given, without reference to the actual state of their hydration in the residue or precipitate.

(To be continued).

A DEDUCTION FROM WAALS'S EQUATION.

By R. H. McCREA.

IT has been stated that this equation gives no explanation of solidification, but a closer investigation of this point may be profitable.

In a solid, the constituent molecules, although free to vibrate, are taken as not free to wander as in the case of a liquid or gas. In other words, the intermolecular spaces, whatever be the ultimate nature of the molecules, have been in the case of the solid for the most part eliminated.

Writing the usual equation—

$$(v - b)\,(p + a/v^2) = K$$

in the form—

$$v - b = \frac{K}{p(1 + a/pv^2)}$$

let a mass of gas be compressed along an isothermal for a temperature above the critical. An increase of pressure in this direction will not produce liquefaction. There probably exists, also, a critical temperature for the solid state. Now, suppose the gas to be compressed along an isothermal above this to a point above the corresponding critical pressure, and then cooled so that its volume remains constant, where this line cuts the critical isothermal the substance will pass into the solid state.

Of course, the above is merely to clear the way for the following piece of extrapolation:—

The curve for the equation approaches to a rectangular hyperbola, and since the line representing the contraction of a solid under pressure is virtually a straight line parallel to the ordinate, and hence in this case to an asymptote of the curve; and as it is known that such a line meets the curve in one point at infinity, hence at an infinite distance along the pressure axis, that is, when the pressure is made infinite, the solid condition is reached.

Now, in the equation, let—

$$p = \infty.$$

Hence the right-hand side of the equation will be diminished infinitely; that is,—

$$v - b = 0.$$

This will happen if $v = b$ for any finite values, or if v and b each $= 0$. Taking the former as the elimination of the intermolecular spaces, and therefore as the attainment of the solid state, we see that the physical interpretation of the previous paragraph is in accordance with this mathematical development.

Now, returning again to the right-hand side,—

$$p + a/v^2,$$

substitute b for v and we get the term a/b^2. In the case of carbon dioxide $a = 0.00874$ and $b = 0.0023$; hence—

$$\frac{a}{b^2} = \frac{0.00874}{(0.0023)^2} = 1652 \text{ atmospheres.}$$

In this case, also, R in the constant has a very small value,—

$$\frac{1.00642}{273}.$$

Hence, neglecting p for the present, we see that—

$$\frac{RT}{a/b^2}$$

may have a very small value, approaching practically zero

When the solid state, then, has once been reached the great tension of the molecules, a/v^2, coupled with a low temperature, T, is sufficient to keep the expression $v - b = o$ practically true, neglecting p; that is, as long as the temperature is kept low a solid may be kept as such through the tension of its molecules, even when the pressure has been greatly reduced.

There are conscious weaknesses in the above chain of reasoning, but it is hoped that it may not be altogether unsuggestive.

A REVISON OF THE ATOMIC WEIGHT OF MANGANESE.*

By GREGORY PAUL BAXTER and MURRAY ARNOLD HINES.

The following table, taken from Clarke's "A Re-calculation of the Atomic Weights" (Smith, Misc. Coll., "Constants of Nature," 1897, Part V., p. 283), gives a brief *résumé* of previous work upon the atomic weight of manganese which has other than historical interest.

O = 16·000.

Berzelius (*Ann. Physik. Chem.*, 1830, xviii., 74)—	
$MnCl_2 : 2AgCl$	55·12
Turner (*Trans. Roy. Soc. Edinb.*, 1831, xi., 143)—	
$MnCl_2 : 2AgCl$	54·92
Dumas (*Ann. Chem. Pharm.*, 1860, cxiii., 25)—	
$MnCl_2 : 2Ag$..	54·98
Von Hauer (*Journ. Prakt. Chem.*, 1857, lxxii., 360)—	
$MnSO_4 : MnS$	54·91
Schneider (*Ann. Physik. Chem.*, 1859, cvii., 605)—	
$Mn : 2CO_2$	54·03
Rawack (*Ibid.*)—	
$Mn_3O_4 : H_2O$	54·08
Dewar and Scott (*Proc. Roy. Soc.*, 1883, xxxv., 44)—	
$AgMnO_4 : AgMnO$	54·86
$AgMnO_4 : 2KBr$	55·02
Marignac (*Arch. Sci. Phys. Nat.*, 1883, [3], x., 21)—	
$MnO : MnSO_4$	55·01
Weeren, (Dissertation, Halle, 1890)—	
$MnO : MnSO_4$	55·00
$MnS : MnSO_4$	55·00

From these results Clarke computes the most probable value to be 54·987.

The close agreement of the greater part of these determinations is striking, the experiments of Schneider and Rawack being the only ones which indicate a value for manganese very different from 55·0. The variations of their results from the others is not surprising, however, since manganoso-manganic oxide and manganous oxalate, with which they worked, are undoubtedly difficult to obtain in a pure condition. The remaining determinations all fall within limits 0·26 of a unit apart, and all but two agree within 0·16 of a unit. Our present knowledge concerning the variety of atomic weights upon which the above determinations are based is not sufficiently certain to lead to the expectation of closer agreement from such widely different methods. (Richards and Wells, "Publications of the Carnegie Institution," No. 28, 1905, p. 67; "Report of the International Committee on Atomic Weights," *Journ. Am. Chem. Soc.*, 1906, xxviii., 6).

For this investigation the substances chosen for examination were manganous chloride and bromide, since the analysis of halogen compounds may be effected with great accuracy. Furthermore, these compounds have not been investigated by any of the more recent experimenters except Dewar and Scott (*loc. cit.*), who performed one analysis each of the chloride and bromide, and obtained the values 54·91 and 54·97 respectively.

Purification of Materials.

Water.—All of the water used in either the purification or the analyses was twice distilled, once from a dilute alkaline solution of potassium permanganate and then from a very dilute sulphuric acid solution. Block-tin condensers were used in both distillations, and the apparatus contained no rubber or cork connections. The water was collected, as a rule, in Jena glass flasks, although for special purposes either platinum or quartz receivers were substituted.

Reagents.—Acids and ammonia also were distilled shortly before use, either platinum or quartz condensers and receivers being employed when necessary. Solid reagents were re-crystallised, usually with centrifugal drainage.

Vessels.—Special pains were taken in all the work to prevent the introduction of alkalis or silica into the purest materials, by avoiding as far as possible the use of glass vessels.

Manganous Bromide.—Four different specimens of manganous bromide were employed, which were obtained from different sources, and were purified in different ways. In the case of Samples A and B, purification of the manganese from other heavy metals was accomplished by re-crystallisation of Merck's "chemically pure" potassium permanganate. Sample A was crystallised three times only, while Sample B was thus treated ten times, the last two crops of crystals being thoroughly drained from the mother-liquors by means of a centrifugal.

In order to free the manganese from potassium and convert it into the bromide, the following processes were employed with Sample A:—First the permanganate was dissolved in water, and was reduced by passing sulphur dioxide into the solution. This sulphur dioxide was made by heating copper turnings with concentrated sulphuric acid, and was purified from copper compounds mechanically carried along by passing through three gas washing-bottles, each containing a solution of sulphurous acid, and one column of beads moistened with a similar solution. From the solution of potassium and manganous sulphates the manganese was precipitated by the addition of an alkaline solution of ammonium carbonate. The manganous carbonate was washed with water until the washings were free from sulphates, then it was dissolved in nitric acid, which had been re-distilled until free from chlorine, and the manganous nitrate was re-crystallised six times from a solution strongly acid with nitric acid, four times in a glass vessel, twice in platinum. Usually it was necessary to start crystallisation by inoculation, and cooling with ice was found advisable for the sake of economy in material. From a dilute solution of the purified nitrate in a platinum vessel, the manganese was again precipitated as carbonate, by means of ammonium carbonate which had been freshly made by passing pure carbon dioxide into distilled ammonia in a platinum flask. The resulting manganous carbonate, after thorough washing with water containing a small amount of ammonia to prevent colloidal solution of the

* From the *Journal of the American Chemical Society*, xxviii., No. 11.

carbonate, was readily converted into bromide by solution in hydrobromic acid. Since it was probable that the carbonate contained occluded nitrate, and since a portion of the material had been oxidised to the manganic state during the washing, it was obvious that bromine would be set free during the solution in hydrobromic acid. The use of a platinum vessel for this purpose was therefore precluded. In order to avoid the introduction of silica, instead of glass vessels, quartz dishes were employed. These have been shown to be practically insoluble in acid solutions (Mylius and Meusser, *Zeit. Anorg. Chem.*, 1905, xliv., 221; see also *prox.*). The free bromine was expelled from the solution of manganous bromide by prolonged heating on a steam-bath in a quartz dish. Finally, it was crystallised six times, thrice in quartz, and, after filtration with a platinum funnel, thrice in platinum with centrifugal drainage after each crystallisation. The crystals were dried as far as possible over stick potash in a vacuum desiccator. From the mother-liquors by means of six similar crystallisations, Sample A_2 was obtained.

In the conversion of Sample B from permanganate to bromide minor changes were introduced. The ammonium carbonate was prepared in a pure state by distilling a solution of commercial ammonium carbonate in a platinum still. Instead of expelling free bromine from the solution of manganous bromide by prolonged heating upon the steam-bath, the solution was evaporated as far as possible upon the steam-bath, and the residue was heated to 200° in an electric oven. The bromide was dissolved in water, and after filtration of the solution was crystallised three times in a platinum dish. The third crop of crystals is designated as Sample C_1.

Sample C_1 was prepared from a commercial specimen of pyrolusite. This was first dissolved in hydrochloric acid, and the solution was boiled to expel chlorine. Hydrogen sulphide was passed into the diluted solution of manganous chloride to saturation, and the precipitate of sulphur and sulphides was removed by filtration. After the excess of hydrogen sulphide had been expelled by boiling, the solution was fractionally precipitated with sodium hydroxide until the precipitate was free from iron. Finally, the manganese was precipitated with ammonium carbonate, and the precipitate was washed and dissolved in nitric acid. The nitrate was re-crystallised and converted into bromide exactly as in the case of Sample A.

The source of Sample D was Merck's "chemically pure" manganous sulphate. A solution of 500 grms. of this salt was first saturated with hydrogen sulphide, and the precipitate, which consisted chiefly of manganous sulphide, was removed by filtration. After the addition of a small amount of ammonia, hydrogen sulphide was again passed into the solution to saturation, and the precipitate discarded. In a similar way third and fourth fractions of sulphide were removed. Next the solution was thrice fractionated with small portions of potassium hydroxide, the precipitate being rejected in each case. Then the manganese was twice precipitated as carbonate by means of ammonium carbonate, and the manganous carbonate was converted into bromide exactly as in the case of Sample B. The first crop of thrice re-crystallised bromide is designated Sample D_1, a second similar crop obtained from the mother-liquors is Sample D_2.

(To be cantinued).

Two New Calcium Ammonium Sulphates.—J. D'Ans.—If a 30 per cent ammonium sulphate solution is boiled with gypsum till the anhydrite disappears, a penta-salt is obtained. It forms refracting prisms and the formula appears to be $(NH_4)_2Ca_5(SO_4)_6 \cdot H_2O$. A second double salt, which is an anhydrous ammonium dicalcium sulphate, is prepared by boiling gyysum in a 40 per cent ammonium sulphate solution. The formula of this is $(NH_4)_2Ca_2(SO_4)_3$. This salt is possibly labile, as in about eight days it gradually decomposes into penta-salt and syngenite. Both salts split up with water, the dicalcium salt forming syngenite in its cooled mother-liquor.—*Ber.*

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

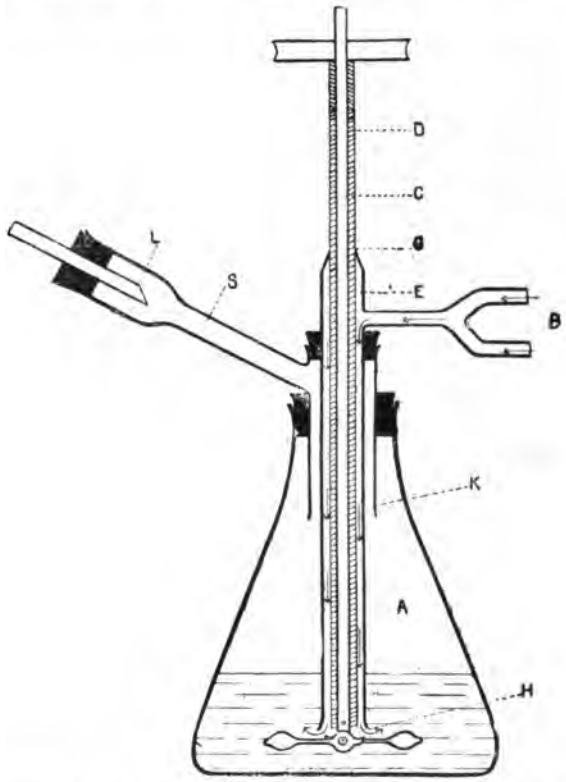
Ordinary Meeting, February 7th, 1907.

Prof. R. Meldola, F.R.S., President, in the Chair.

(Concluded from p. 92).

33. "*A Simple Apparatus, with Stirrer, for Treating a Liquid at its Boiling Point with two or more Gases.*" By Norman Leslie Gebhard.

Whilst studying the action of certain gases on liquids at their boiling points, the apparatus represented in the figure was devised and found very satisfactory.



The liquid is placed in an Erlenmeyer flask A, of capacity appropriate to the volume of liquid under treatment. The rest of the apparatus includes a centrifugal stirrer in the liquid, driven by a water turbine through a horizontal pulley, the rod C carrying the stirrer rotating in an outer tube D. At G, D is sealed into a tube E, of slightly wider bore. The tube E reaches almost to the stirrer and dips well below the surface of the liquid. The gases enter at the tubes B, pass along the annular space between D and E, as indicated by the arrows, and encounter the liquid at H just above the stirrer. The upper part of E is surrounded for part of its length by a wider tube K with a side tube S, through which the vapour of the boiling liquid passes to be condensed in the reflux condenser L. E is fitted to K and the latter to the flask by means of suitable corks. The apparatus enables a liquid, in vigorous ebullition, to be subjected to the action of gases, with constant stirring, and can be constructed without difficulty by anyone with a moderate knowledge of glass-blowing.

34. "*Note on the Arsenates of Lead and Calcium.*" By SPENCER PICKERING.

Crystallised sodium arsenate of commerce consists of the disodium salt, generally united with 7, but sometimes with 12, molecules of water of crystallisation. In either case, this water may all be expelled at 100°, and decomposition into the pyro-arsenate commences at 150°. The preparations dried at 300° in accordance with the Pharmacopœia are, therefore, overheated. With lead acetate, all commercially pure samples give a precipitate of triplumbic arsenate; but with lead nitrate, the precipitate consists of the diplumbic salt, mixed, occasionally, with a certain amount of the tri- or mono-plumbic arsenates. With preparations of crude sodium arsenate, the amount of lead salt required for precipitation varies considerably, and there is an indication that a compound of the di- and tri-plumbic salts may sometimes be formed.

With calcium chloride or nitrate, sodium arsenate forms the tricalcium arsenate; but, when thus prepared, it is not very insoluble, and is, therefore, unsuitable as an insecticide. But it may be completely precipitated by calcium hydroxide; and thus a mixture of lime and sodium arsenate may be used as a substitute for lead arsenate.

35. "*Camphor-β-sulphinic Acid and Camphorylsulphonium Bases.*" By SAMUEL and THOMAS PERCY HILDITCH.

Camphor-β-sulphinic acid has been prepared by the reduction with zinc dust of the chloride of Reychler's camphorsulphonic acid. It was further shown that the acid when mixed with a phenolic ether and a dehydrating agent behaves in a similar manner to the aromatic sulphinic acids and yields the camphoryl sulphonium bases. The sulphinic acid and those sulphonium bases which have been prepared exhibit a strong lævorotatory power in distinction from the dextrorotatory sulphonic acid from which they were obtained. With the object of ascertaining whether this change in rotatory power is due to any alteration in structure of the camphor complex, the sulphinic acid was oxidised, and it was found that the products were the original sulphonic acid and *d*-camphoryl-α-disulphone. The authors conclude that the above change is probably caused by the conversion of the sulphur from the sexavalent to the quadrivalent state.

36. "*The Condensation of Salicylamide with Aryl Aldehydes.*" By CHARLES ALEXANDER KEANE and WILLIAM WALTER SCOTT NICHOLLS.

Benzaldehyde, when heated with salicylamide in presence of hydrochloric acid or of sodium acetate, condenses to form a cyclic compound, in the production of which one molecular proportion of the amide reacts with one of the aldehyde. The substance gives no colouration with ferric chloride, indicating that the hydroxyl group of the salicylamide has participated in the condensation, and it yields an acetyl derivative which is decomposed by concentrated sulphuric acid with the formation of *N*-acetylsalicylamide. It is accordingly regarded as a cyclic compound of the oxazine group, namely, 2-*phenyl*-1 : 3-*benzoxazone*, $C_6H_4\begin{cases}CO\cdot NH\\ |\\ O—CHPh\end{cases}$; an alternative tautomeric formula is of course also possible. It crystallises from alcohol in silky needles which melt at 169°. On prolonged boiling with water it is gradually decomposed into its constituents; this decomposition is very readily effected by alkalis, less readily by dilute mineral acids. Heated with aniline, benzylideneaniline and salicylamide are formed. The *acetyl* derivative crystallises from alcohol in slender prisms which melt at 88°. It is decomposed into its constituents by heating with dilute alkalis or with dilute mineral acids, and when heated with aniline forms acetanilide, benzylideneaniline, and salicylamide.

2-p-*Methoxyphenyl*-1 : 3-*benzoxazone*,—

$$C_6H_4\begin{cases}CO\cdot NH\\ |\\ O—CH\cdot C_6H_4\cdot OMe\end{cases},$$

is prepared by the condensation of salicylamide with anisaldehyde. It melts at 166—167° and forms an *acetyl* derivative which melts at 91°, and resembles the corresponding phenyl compound in its chemical behaviour.

*Benzylidene*bis-o-*methoxybenzamide*—

$$C_6H_5\cdot CH:(NH\cdot CO\cdot C_6H_4\cdot OMe)_2,$$

prepared by the condensation of *o*-methoxybenzamide with benzaldehyde, is much more stable towards alkali than the above cyclic compounds, and is not acetylated by heating with acetic anhydride. It crystallises from alcohol in fine needles melting at 156°.

37. "*The Condensation of Diethylmalonamide with Aldehydes.*" By HARRY BURROWS and CHARLES ALEXANDER KEANE.

Diethylmalonamide, when heated with benzaldehyde in presence of hydrochloric acid, condenses similarly to salicylamide (Compare Keane and Nicholls, preceding abstract) to form a cyclic compound of the pyrimidine group: 4 : 6-*diketo*-2-*phenyl*-5 : 5-*diethylhexahydropyrimidine*, $CHPh\begin{cases}NH\cdot CO\\ NH\cdot CO\end{cases}CEt_2$. It crystallises in prisms which melt at 262°; it is stable towards dilute mineral acids, but is decomposed by boiling with sodium hydroxide solution. Heated with acetic anhydride it forms a *diacetyl* derivative which melts at 147° and which is decomposed with elimination of the acetyl groups by treatment with concentrated sulphuric acid.

The corresponding *cinnamyl* compound melts at 241° and also forms a *diacetyl* derivative which melts at 125°.

Chloral-diethylmalonamide, $CEt_2(CO\cdot NH_2)_2,CCl_3\cdot CHO$, is prepared by condensing molecular pyoportions of diethylmalonamide and choral hydrate with hydrochloric acid. It melts at 178° and is stable towards boiling water or hot dilute hydrochloric acid.

OBITUARY.

DEATH OF PROFESSOR HENRI MOISSAN.

THE death of Prof. Henri Moissan has robbed the scientific world of one of its most distinguished sons, whose brilliant researches have led to the discovery of many important substances, some of purely theoretical and others of practical interest. Prof. Moissan's name is most widely known in connection with the electric furnace, which he perfected and with which he carried out many fruitful researches. Thus with its aid he succeeded in obtaining temperatures ranging from 3500° to 4000° C., the latter the highest which has yet been reached, and at which he showed that all known elements and compounds may be vaporised. His work on the furnace extended over the years 1892 to 1899, and his text-book, "Le Four Electrique," which described his apparatus and the results of his researches, was translated both into English and German.

One of Prof. Moissan's earliest and most striking achievements was the isolation of fluorine in 1887 by the decomposition by means of a powerful electric current of anhydrous hydrofluoric acid, to which a small quantity of potassium fluoride had been added, and his description of the properties of this element, which up to that time had resisted all attempts to prepare it in the free state, awakened great interest. He subsequently proved the composition of hydrofluoric acid, showing that it is exactly analogous to the acids of the other halogens. His experiments with fluorine further led him to the preparation for the first time of important compounds of it with various elements; for instance, the phosphorus compounds, phosphorus trifluoride and oxyfluoride. Thence he turned his attention to the halogen compounds of boron and silicon, while he devoted much time to the preparation of carbides, some of which, for instance, calcium carbide

have acquired considerable technical importance. The crystalline carbide of silicon or carborundum, which is characterised by its extreme hardness and its resistance to reagents, has found application in the polishing of the hardest kinds of steel and stones, and was also one of Moissan's discoveries, although Acheson had prepared the same compound independently.

The year 1893 saw Moissan's memorable work on the artificial production of the diamond, on which he spent much patient labour. Induced by his study of the decomposition of the fluorides of carbon, which he hoped would lead to the preparation of a crystallised form of carbon, he examined the properties, and more especially the ash, of diamonds from many sources, and was thence led to investigate the action of high temperatures upon various forms of carbon and the separation of the element from fused metals, while the examination of the Cañon Diablo iron, in which "nature seems to have been caught in the act," gave him the final hint. All students of science are familiar with the method by which he made a solution of carbon in fused iron and suddenly cooled it by plunging it into cold water; the sudden cooling and the enormous pressure resulting from the increase of volume undergone by the molten iron as it solidified produced artificial diamonds. In the same year Moissan succeeded in fusing metallic chromium and isolating many compounds of tungsten and molybdenum, while more recently he has described methods of preparing the pentafluoride of iodine by the direct action of fluorine on iodine, and also sulphur hexafluoride, a compound which is interesting in that it demonstrates beyond any doubt the hexavalence of sulphur.

Moissan's researches were confined more especially to inorganic chemistry, which has been greatly enriched by his discoveries; his experimental skill amounted to genius, and his originality and resource were such as to enable him to attack successfully many practical problems which his contemporaries had almost begun to regard as insoluble. His work is a record of victory over apparently insuperable difficulties, and he forced the most refractory and unmanageable of substances to yield to his mastery. He was perhaps the greatest of the French school who have devoted themselves to the synthesis of minerals with such brilliant results, and his untimely death has brought to a sudden end labours unequalled in the regions of chemical mineralogy.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 6, February 11, 1907.

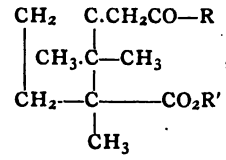
Preparation of the Acylcampholic Ethers, and a New Method of Formation of Phenyloxyhomocampholic Acid.—A. Haller and Charles Weimann.—Cyanocampholic ethers, like all nitriles, react with organomagnesium compounds to give—first, imide compounds, and then, by hydrolysis, ketone derivatives, through the action of dilute sulphuric acid :—

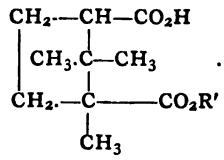
$$C_8H_{14}\begin{cases}CH_2CN\\CO_2R\end{cases} + Mg\begin{cases}R'\\I\end{cases} = C_8H_{14}\begin{cases}CH_2.C\overset{NMgI}{=}R'\\CO_2R\end{cases},$$

$$C_8H_{14}\begin{cases}CH_2-C\overset{NMgI}{=}R'\\CO_2R\end{cases} + 2H_2O =$$

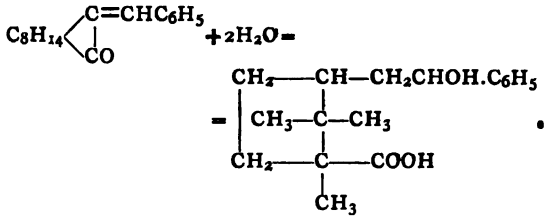
$$= C_8H_{14}\begin{cases}CH_2.COR'\\CO_2R\end{cases} + Mg\begin{cases}OH\\I\end{cases} + NH_3.$$

Under the conditions with which the authors experimented, the organo-magnesium compound had effect only upon the nitrile group, leaving the COOR group untouched. It was found difficult to saponi these bodies into the corresponding acids, $C_8H_{14}\begin{cases}CH_2COR\\COOH\end{cases}$, since the COOR' group of these ketonic ethers occupies the same position in the molecule as that ascribed to the same group in the β-camphoric acid ethers :—





The ketonic function of these compounds is readily manifested by the preparation of the semicarbazones. The following bodies are described :—Methyl acetylcampholate, $C_8H_{14}\begin{cases}CH_2CO.CH_3\\CO_2CH_3\end{cases}$, a colourless oil distilling at 190° under a pressure of 50 mm.; its semicarbazone, $C_{14}H_{25}O_3N_3$, fine white needles melting at 251°. Ethyl propionylcampholate, $C_8H_{14}\begin{cases}CH_2.CO.CH_2.CH_3\\COOC_2H_3\end{cases}$, a yellowish oil distilling at 198° under 25 mm.; its semicarbazone, $C_{16}H_{29}O_3N_3$, fine silky needles melting at 180·5°. Methyl benzoylcampholate, $C_8H_{14}\begin{cases}CH_2.CO.C_6H_5\\CO_2CH_3\end{cases}$, consisting of flakes fusing at 71°; its semicarbazone melts at 222°. Ethyl benzoylcampholate, $C_8H_{14}\begin{cases}CH_2.CO.C_6H_5\\CO_2C_2H_5\end{cases}$, crystals melting at 48—49°; its semicarbazone melts at 180°. Benzoyl campholic acid, $C_8H_{14}\begin{cases}CH_2.CO.C_6H_5\\COOH\end{cases}$. This acid is the ketonic compound corresponding to phenyloxyhomocampholic acid, $C_8H_{14}\begin{cases}CH_2.CHOH.C_6H_5\\COOH\end{cases}$, which the authors have obtained by treating benzylidene camphor with hydrochloric or hydrobromic acid, or by reacting with potassium upon β-brom-benzyl camphor. The compound thus obtained differing from benzylidene camphor by two additional molecules of water and possessing an acid group, may be represented as follows :—



The benzoylcampholate of silver is obtained by double decomposition, as a white precipitate, insoluble in most solvents; the semicarbazone of the acid, $C_{18}H_{25}N_3O_3$, melts at 210°. Phenyloxyhomocampholic acid, $C_8H_{14}\begin{cases}CH_2.CHOH.C_6H_5\\COOH\end{cases}$, prepared by reduction of benzoyl campholic acid with sodium amalgam. It was found that an identically similar body was produced by hydrating benzylidene camphor, and its formula as that of an ϵ-oxyacid is well established. Its melting-point is 200° to 202°.

Various Syntheses of Dimethyl Isopropyl Carbinol, $(H_3C)_2.C(OH)—CH.(CH_3)_2$.—Louis Henry.—The author gives an account of various synthetic reactions, which result in the formation of dimethyl-isopropyl carbinol, $(H_3C)_2.C(OH)—CH.(CH_3)_2$. These appear to be accompanied by an intramolecular transposition of elements, which, however, is not borne out by fact and needs explanation; there occur also successive intermediate reactions, which are important to notice. I. α-Chloroisobutyric aldehyde, $(H_3C)_2—CCl—CH=O$, reacting with magnesium-methyl bromide, produced, not pinacolic alcohol according to expectation, but its tertiary isomer,

dimethyl-isopropyl carbinol, $(H_3C)_2.C(OH)—CH.(CH_3)_2$. The successive steps of the reaction may be explained as follows:—

$$\begin{matrix} H_3C \\ H_3C \end{matrix}\!\!>\!CCl—CH—CH_3 \rightarrow \begin{matrix} H_3C \\ H_3C \end{matrix}\!\!>\!C—CH—CH_3 \rightarrow$$
$$\qquad\qquad O.MgBr \qquad\qquad \backslash O /$$

$$\rightarrow \begin{matrix} H_3C \\ H_3C \end{matrix}\!\!>\!C - CH\!<\!\begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!;$$
$$\qquad\qquad O.MgBr$$

whence, finally, by the decomposing action of water, dimethyl-isopropyl carbinol is obtained. II. Amylene monochlorhydrin, $(H_3C)_2CCl—CH(OH)—CH_3$, results from the addition of HCl to the oxide of trimethyl-ethylene, $(H_3C)_2—C—CH—CH_3$. The reaction of this product upon magnesium-methyl bromide produces, not, as might be expected, secondary pinacolic alcohol, but its isomer dimethyl-isopropyl carbinol, the course of the reaction being the same as the steps already expressed.

Phenomenon Observed with Regard to a Dissolved Chromic Salt. — Albert Colson. — The author's experiments upon the green polymerised salt, obtained by heating the violet sulphate of chromium, have shown that condensation is more complete at 90° than at 110°. In another series of experiments he has proved that this anomaly is explained by the effect of the solvent upon the bodies once dissolved. The following are the results of observation of the points of solidification of the solutions made at regular intervals:—

Lowering.	Salt obtained at 110°. Solution at 1/10 mol.	Salt obtained at 90°. Solution at 1/10 mol.	Salt obtained at 90°. Solution at 2/10.
As soon as dissolved	0·29°	0·21°	—
3 hours after	0·35°	0·33°	0·58
6 „	0·39°	0·38°	—
24 „	0·415°	0·415°	0·76

Thus the green molecule of chromic sulphate, obtained by heating the violet sulphate above 90°, exists in two states of solution, under the same conditions of temperature and solvent, an initial state of condensation of the form $[Cr_2(SO_4)_3]_2$, and a normal state, $Cr_2(SO_4)_3$, resulting from the slow dissociation of the former. According to van't Hoff's hypothesis, in which the dissolved state is made comparable to the gaseous state, this phenomenon may be compared to the case of a solid, which, reduced to vapour in a determined space, presents two gaseous states at the same temperature. It is the inverse of the vapours of phosphorus and of cyanogen, which correspond to two different solid states, white phosphorus and red phosphorus in the first, paracyanogen and solidified cyanogen in the second case. Polymerisation of the chromic salt is still more marked when the concentration reaches to the melting of the salt in its water of crystallisation. These properties appear common to all green sulphates prepared in the cold.

Alcoholisation of Metallic Cyanides.—H. Guillemard. —In a long series of experiments the author has investigated the variation as a function of the temperature and duration of the reaction, in the quantities of nitrile and carbylamine formed, when alcoholising agents, such as iodides, alcoholic sulphates, and sulphovinates, are made to react upon different cyanides. The general conclusion drawn from the facts obtained is that the cyanides thus treated yield, at a low temperature carbylamines, at a higher temperature a mixture of carbylamine and nitrile, and above a certain temperature nitriles only. Thus, at a low temperature the cyanides correspond to the formula MNC. The formation of nitriles at a higher temperature may be explained by several hypotheses; either the constitution of the cyanides becomes modified, the molecules in increasing number taking the formula MCN, and becoming an allotropic mixture whose state of equilibrium is a function of the temperature; or, the constitution of the cyanides remaining unaltered, they react differently at different temperatures; or, finally, the carbylamine, which alone is produced at a low temperature, isomerises at a higher temperature, to adopt the more stable constitution of ordinary nitriles. All points to the latter hypothesis being the correct one, it having been proved that carbylamines isomerise very readily.

Catalytic Hydrogenation of the Non-saturated Ether Salts. — G. Darzens. — A general method of synthesis of the saturated ketones, $C_nH_{2n}O$, by the catalytic hydrogenation of the non-saturated ketones, $C_nH_{2n-2}O$, having been already described, the author now applies the same method, in another series, to the synthesis of saturated bodies, viz., the preparation of saturated acids from the ethers of the non-saturated ethylene acids $C_nH_{2n-2}O_2$. I. *Fatty Series.*—A whole series of $\beta\beta$-methyl-alkyl-acrylic ethers of the type $\begin{matrix} R \\ CH_3 \end{matrix}\!\!>\!C=CH—CO_2C_2H_5$ gave rise to fatty acids of the general formula $\begin{matrix} R \\ CH_3 \end{matrix}\!\!>\!C—CH_2—CO_2C_2H_5$. II. *Aromatic Series.*—The catalytic hydrogenation of the cinnamic ethers readily produced the corresponding phenylpropionic ethers. III. *Hydroaromatic Series.*—$\Delta(1.2)$-Tetrahydrobenzoic acid was obtained from cyclohexanone; also hexahydrophenylacetic acid, and their methods of preparation are described. The experimental results show clearly the difference existing between catalytic hydrogenation and that effected by sodium in presence of boiling alcohol. The latter transforms the group —COOR into $—CH_2OH$, frequently also reacting with the aromatic radicals and ethylene groups in the $\alpha\beta$-position. Catalytic hydrogenation, on the other hand, generally leaves untouched the aromatic radicals and the COOH group, whilst the ethylene groups is always hydrogenated, whatever its position. These methods give a practical means of effecting the synthesis of an acid of the type C_{n+2}, starting from an aldehyde or ketone of the formula C_n.

Transformation of the Primary Saturated Alcohols into the Corresponding Monobasic Acids. — H. Fournier.—The author has effected the transformation of the primary saturated alcohols into monobasic acids possessing the same number of carbon atoms, by means of alkaline potassium permanganate, instead of the chromic mixture ordinarily used, which, being acid, always produces a large proportion of aldehyde or ether salt. It has hitherto been believed that the use of alkaline potassium permanganate gives only a very small yield of the monobasic acid, but it is now proved that under suitable conditions a very good yield is obtained, varying from 70 per cent to 75 per cent.

Berichte der Deutschen Chemischen Gesellschaft.
Vol. xl., No. 1, 1907.

Intermediate Products in Alcoholic Fermentation.—Arthur Slator.—The author has shown that lactic acid is not an intermediate product in the fermentation of glucose by means of yeast to alcohol and carbon dioxide. For, in the first place, lactic acid is either not destroyed by yeast or only very slowly and incompletely, whereas if it is an intermediate product it must disappear as quickly as it is formed, or else it would be found in the solution; secondly, lactic acid when added to a fermenting liquid retards fermentation slightly instead of increasing it; and, lastly, although small quantities of lactic acid have been isolated during fermentation, this fact cannot be adduced as an argument that it is an intermediate product, and it is much more probable that it is a by-product. If an intermediate product does exist it must satisfy the following conditions:—(1). It must ferment at least as quickly as, and perhaps much more quickly than, glucose; (2) it must disappear quickly when introduced into a fermenting solution; and (3) it must be difficult to isolate it from such a solution.

Sulphur Dye-stuffs.—H. Wichelhaus.—Many natural dye-stuffs, such as brazilin, hæmatoxylin, maclurin, euxanthone, can be converted into sulphur dye-stuffs by the following method:—Three parts of the substance are heated to 250—300° with six parts of sulphur. Evolution of sulphuretted hydrogen proceeds vigorously for six to eight hours, The product is dissolved in caustic soda, and precipitated with acid; then it is heated to 120° to convert the amorphous sulphur into the soluble modification, and the latter is removed by means of carbon disulphide. The same process can be carried out with artificial dye-stuffs which possess a phenol character, such as fluorescein, and in this case there is no need to prepare the fluorescein beforehand, for the sulphur dye is obtained if phthalic acid, resorcin, and sulphur are fused together. The dye thus prepared appears to differ from Gattermann's thio-fluorescein, but as its analysis presents great difficulties the author does not feel justified in drawing any definite conclusions as to its composition.

Relative Stability of some Metallic Amine Derivatives.—L. Tschugaeff.—The investigation of the formation of amine derivatives of copper, silver, platinum, and nickel has shown that the power of the amines to form complexes is dependent upon the number of unsubstituted hydrogen atoms. By the replacement of the first ammonia hydrogen by an alkyl the proportions seems to be but little changed, but when the substitution process has been repeated the power of forming complexes is greatly affected, and is destroyed by the replacement of the third ammonia hydrogen. The power of forming complexes is a property of many amines of different affinity constants; and, moreover, two amines which have almost the same affinity constants, *e.g.*, ethylamine and tripropylamine, behave differently as regards the formation of complexes. Hence the power is influenced not only by the basic properties of the ammonia or amine nitrogen, but also by other factors.

Chromium Boride.—E. Wedekind and K. Fetzer.—Hitherto no boride of chromium of definite composition has been described, although the preparation of such a compound would be of interest in view of the fact that borides of iron, cobalt, and nickel of the formula MeB have been obtained. The reason for this is that it is extremely difficult to prepare a pure chromium boride by the usual method of heating the constituents, or a mixture of boron and chromium oxide in the electric furnace, because the carbon vapour from the electrodes is taken up by the fused product, some of it being combined, while the rest separates out on cooling as graphite. The authors' method does away with this difficulty. They allowed the liquefied metal formed from chromium thermite to act on the calculated amount of boron. The latter was prepared by Moissan's method from boric acid anhydride and magnesium. Before the beginning of the experiment the chromium thermite was converted into a pulp with liquid air. Then amorphous boron was placed at the bottom of a Hessian crucible, covered with chromium thermite, and then with the above thick liquid. Then a mixture of barium peroxide and aluminium was mixed with this upper layer. The reaction was violent, and, after cooling, the regulus was broken up in a steel mortar and treated with warm dilute hydrochloric acid to remove the excess of uncombined chromium, then with nitric acid, and finally with aqua regia. After washing with water and drying, a silver-white crystalline powder was obtained. Chromium boride is characterised by its extraordinary resistance to acid and alkaline reagents. Even hydrofluoric acid and mixtures of hydrofluoric and nitric acid have no effect upon it, and the authors found that sodium peroxide is the only substance which would decompose it into its constituents. For the analysis the compound was heated in a silver crucible with sodium peroxide, chromate and borate being formed. The melt was boiled with water and the chromium oxide filtered off. To the clear filtrate some drops of helianthin and hydrochloric acid were added, till the reaction was neutral. After cautiously heating for some time on the water-bath (to drive off carbon dioxide) about one-third of the total volume of pure glycerin was added, with some drops of phenol-phthalein, and then the liquid was titrated with N/10 sodium hydroxide. The chromium hydroxide filtered off was dissolved in hydrochloric acid, precipitated with ammonia, washed, and ignited. The chromium boride was not quite pure, but contained some uncombined metal; nevertheless, there could be no doubt from the analysis that it has the simple formula CrB, corresponding to FeB, CoB, NiB, and MnB. Its specific gravity is 5·4 at 17°. It conducts an electric current, and is very hard, scratching glass and quartz easily. It is fusibly only with difficulty, and can be heated to a red heat in a current of oxygen for some time without undergoing any alteration. Hydrochloric acid gas acts upon it only very slowly. It possesses ferro-magnetic properties, and is attracted by a powerful electro-magnet.

Products obtained from the Carbonates of the Alkaline Earths, Carbon, and Nitrogen.—O. Kuhling.—The author has determined the relative quantities of cyanide and cyanamide formed when carbon and nitrogen act upon the carbonates of the alkaline earths at temperatures from 900° to 1400°. He used one molecule of the pure carbonate to three atoms of sugar carbon, and exposed the mixture to the action of nitrogen. The cyanide was determined by Feld's method, and the cyanamide by a modification of Perotti's process with ammoniacal silver solution. The experiments show that the tendency to absorb nitrogen is greatest in the case of barium carbonate and less with strontium carbonate, while calcium carbonate only absorbs traces. The mixture containing barium carbonate forms chiefly cyanide, and the calcium carbonate mixture cyanamide salt, while the strontium salt occupies an intermediate position. The addition of the corresponding chlorides increases the absorption of nitrogen, but in the case of the barium salt this increase is effected only by small amounts of chloride, and in the presence of larger quantities the percentage of nitrogen absorbed again decreases. If the nitrogen is charged with water-vapour, the temperature necessary for the reaction is increased and the yield reduced.

Carbon Suboxide (II.).—Otto Diels and George Meyerheim.—Further researches have shown that not only malonic acid diethyl ester, but also the dimethyl, dibenzyl, and diphenyl esters yield carbon suboxide when treated with phosphorus pentoxide. Methenyl tricarbonic ester acts similarly:—

$$CH(CO_2C_2H_5)_3 = 3C_2H_4 + CO_2 + 2H_2O + OC:C:CO.$$

Also free malonic acid itself, when heated with phosphorus pentoxide, is converted into the suboxide—

$$CH_2(COOH)_2 = 2H_2O + OC:C:CO,$$

and simultaneously carbon dioxide and acetic acid are formed, $CH_2(COOH)_2 = CH_3.COOH + CO_2$. The yield from malonic acid is about 10 to 12 per cent of the theory, and this method of preparing the suboxide is more convenient than using the ester, and was therefore employed for the authors' subsequent experimental work. Twenty grms. of pure finely-powdered malonic acid are thoroughly mixed with 200 grms. of phosphorus pentoxide in a large dry flask, which is connected first with a vessel cooled by means of ice and salt and then with a vessel cooled by liquid air. The whole apparatus is exhausted to about 0·1 to 0·2 mm. pressure, and then the flask containing the mixture is placed in an oil-bath heated to 140—150° for three-quarters of an hour. The vessel cooled with liquid air then contains a white mass consisting of carbon dioxide and suboxide. The former is slowly driven off by placing the vessel in an empty Weinhold's vessel, and then the suboxide can be allowed to boil off at the ordinary temperature into a cooled receptacle. The acetic acid formed is generally converted by means of the carbon

dioxide into other compounds. The melting-point of carbon suboxide is -107°, and its specific gravity in the liquid state is 1·11 at 0°. At low temperatures (0—15°) the suboxide is converted into a polymer or mixture of polymers, while at higher temperatures gaseous products are formed, among which carbon monoxide and dioxide are found, and a residue of composition varying according to the transition temperature is left. If the polymer $(C_3O_2)_x$, prepared at a low temperature, is heated, carbon dioxide, carbon monoxide, and carbon suboxide all result, the last named in fairly large quantities. The residue, even when heated to a red heat, does not consist of carbon, but has the composition of a carbon oxide very poor in oxygen. The polymer very readily takes up water in the air, and carbon dioxide is split off. When cold water is added to the polymer, a development of heat occurs, carbon dioxide is evolved, and an eosin-red solution is produced. The authors think that the physical constants of the suboxide all show that the formula is OC:C:CO.

MISCELLANEOUS.

Society of Arts.—*Prize for Industrial Hygiene.*—The Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a Gold Medal, or a prize of £20. The Medal, under the conditions laid down by the testator, is to be given "For any discovery, invention, or newly-devised method, for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means." Intending competitors should send in descriptions of their inventions not later than December 31st, 1907, to the Secretary of the Society of Arts, Adelphi, London, W.C. Such descriptions may be sent in under the inventor's name, or under a motto, accompanied by a sealed envelope, enclosing the name, as preferred. The Judges will be appointed by the Council. The Council reserve the right of withholding the prize or of awarding a smaller prize or smaller prizes, if in the opinion of the Judges nothing deserving the ful award is sent in.

Merchant Venturers' Technical College, Bristol.—Since the disastrous fire which partially destroyed the main building of this College in October last, a Committee of the Society of Merchant Venturers has had under consideration the course which it should recommend the Guild to adopt. Various sites for the re-erection of the College have been suggested and carefully discussed, and a report has now been submitted to the Society advising the retention of the present site, which is particularly central, close to the tramway terminus, and within easy reach of the three principal railway stations of Bristol. At a general meeting held on Friday last this report was received and unanimously adopted, and steps will therefore be taken at once to replace the various laboratories, workshops, lecture theatres, &c., with all possible speed. Little time has been lost since the building was handed over to the Merchant Venturers by the firm in charge of the salvage arrangements, as the interval has been utilised to clear the building of *débris* and to remove certain weak portions of the walls. In framing plans for re-building, the Merchant Venturers will bear in mind the possibility that at some future period the College may be called upon to take its proper part in the formation of the proposed University of Bristol.

MEETINGS FOR THE WEEK.

MONDAY, 4th.—Society of Arts, 8. (Cantor Lectures). "Romanesque Ornament," by F. Hamilton Jackson.
—— Royal Institution, 5. General Monthly Meeting.
—— Society of Chemical Industry, 8. "Exhibition of a Gas Calorimeter," by Prof. C. V. Boys. "Four Years' Experience in Metering Producer Gas, and Continuously Recording its Calorific Power," by Prof. R. Threifall.

TUESDAY, 5th.—Royal Institution, 3. "The Visual Apparatus of Man and Animals," by Prof. William Stirling.
—— Society of Arts, 4.30. "British Malaya," by Sir William Hood Treacher.

WEDNESDAY, 6th.—Society of Arts, 8. "The Discovery of the South Eastern Coalfield," by Prof. W. Boyd Dawkins.
—— Society of Public Analysts, 8. "Disposition and Analyses of Sewage Matters Deposited on Superposed Surfaces," by W. J. Dibdin. "Composition of Milk," by H. Droop Richmond. "Preservatives in Milk and Milk Products," by H. Droop Richmond and E. H. Miller.

THURSDAY, 7th.—Royal Institution, 3. "Old Dutch Painting and Painters," by Dr. W. Martin.
—— Chemical. 8.30. "Constitution of Chaulmoogric and Hydnocarpic Acids," by M. Barrowcliff and F. B. Power. "Volume Changes which accompany Transformations in the System $Na_2S_2O_3,5H_2O$," by H. M. Dawson and C. G. Jackson.

FRIDAY, 8th.—Royal Institution, 9. "Certain Seasonal Diseases of the Sheep, and the Means of Preventing them," by Prof David J. Hamilton.
—— Physical, 8. "Rate of Recovery of Residual Charge in Electric Condensers," by Prof. Trouton and Mr. Russ. "Experimental Mathematics," by Mr. Pichon. "An Instrument to Describe Families of Equiangular Spirals," by Mr. Blakesley. "A Micromanometer," by Mr. Roberts.

SATURDAY, 9th.—Royal Institution, 3. "Röntgen, Cathode, and Positive Rays," by Prof. J. J. Thomson.

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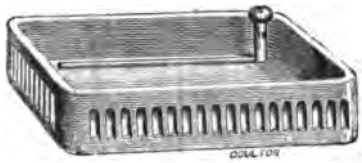

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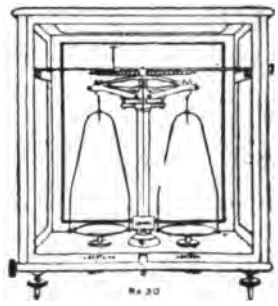

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THE CHEMICAL NEWS.

Vol. XCV., No. 2467.

ON A NEW IRON CARBONYL, AND ON THE ACTION OF LIGHT AND OF HEAT ON THE IRON CARBONYLS.*

By Sir JAMES DEWAR, M.A., Sc.D., LL.D., F.R.S., Jacksonian Professor in the University of Cambridge, and HUMPHREY OWEN JONES, M.A., D.Sc., Fellow of Clare College, and Jacksonian Demonstrator in the University of Cambridge.

(Concluded from p. 99).

Decompositian of Iron Pentacarbonyl Absorbed in Alumina.

During the course of some experiments on the absorbing power of various substances for gases and vapours, it was found that alumina absorbed 2·5 per cent of its weight of iron pentacarbonyl from gases saturated with the vapour at the ordinary temperature. On exposing this alumina to light (out of contact with air) it became coloured—first pink, then red, reddish purple, and finally a dark reddish purple. Experiments showed that during this action carbon monoxide was evolved in approximately the theoretical quantity, if care were taken to shake the alumina frequently so as to expose it all to light.

The solid diferro-nonacarbonyl formed in the alumina possibly forms a kind of "lake" with the alumina. The coloured alumina retains its colour when boiled with pyridine, although alumina will not remove the colour from the red pyridine solutions of diferro-nonacarbonyl. Warm concentrated hydrochloric acid removes the colour, gas is evolved, and ferrous chloride is formed; nitric acid reacts with the coloured alumina in the cold, but sulphuric acid has very little action on it.

Action of Heat on Diferro-nonacarbonyl.

As stated by Mond and Langer, and confirmed in our previous communication, the solid, when heated alone, breaks up into iron pentacarbonyl, iron, and carbon monoxide. It was observed that the iron pentacarbonyl so produced was coloured green, but that when distilled the green colour was removed from it. This decomposition occurs at about 95° C.

Quantitative experiments were made in which a weighed quantity of the solid was placed in a porcelain boat and heated in a stream of hydrogen to a temperature of about 100° to 120° C. by means of a toluene- or an air-bath; the volatile iron pentacarbonyl was thus carried off as vapour and passed through a glass tube, bent twice on itself and heated in an air-bath to a temperature of about 200° C. The boat and the coiled tube were weighed after the experiment, and so the amount of left iron and the amount of iron deposited from the volatile carbonyl were determined. The boat was then heated in a current of oxygen until there was no further change of weight, and so a second determination of the iron made as ferric oxide.

The following are typical experiments performed in this way:—

Grm.		Grm.		Grm.	
0·2981	$Fe_2(CO)_9$ gave	0·0754	Fe in tube and	0·0223	Fe in boat
0·4505	,,	0·1211	,,	0·0378	,,
0·6555	,,	0·1215	,,	0·0725	,,

It is evident that this method does not give consistent results, and even if it did it would probably give values for the iron deposited in the bent tube from the iron pentacarbonyl that were too high, since it has been shown that the iron so deposited always contained carbon.

Other experiments were then made in which the iron pentacarbonyl was collected and weighed.

A weighed quantity of diferro-nonacarbonyl was placed in one limb of a U-shaped tube, which was then exhausted and sealed. This limb of the tube was heated and the iron pentacarbonyl which was formed was condensed in the other limb by cooling this in liquid air. The iron pentacarbonyl and the residue left in the other limb of the tube were weighed. The residue was found to be iron in such a finely-divided state that it was pyrophoric.

The following experiments are typical. In the first experiment the solid was heated to 100° C. and in the second to 110° to 115° C.

Grm.		Grm.		Grm.	
0·685	$Fe_2(CO)_9$ gave	0·567	$Fe(CO)_5$ and	0·055	Fe
0·587	,,	0·453	,,	0·039	,,

In the former communication it was stated that the decomposition might be represented by the equation $2Fe_2(CO)_9 = 3Fe(CO)_5 + Fe + 3CO$.

The above results confirm this, since the amounts of $Fe(CO)_5$ formed on this view would be 0·583 and 0·503 grm. respectively, and the amounts of iron would be 0·053 and 0·045 grm. respectively.

Since it is shown later that, by the action of heat on diferro-nonacarbonyl in presence of solvents below 100° C., a compound, $Fe(CO)_4$, is produced, it is quite possible that the decomposition was produced in two stages, represented by the equations $2Fe_2(CO)_9 = 2Fe(CO)_5 + 2Fe(CO)_4$ and $2Fe(CO)_4 = Fe(CO)_5 + Fe + 3CO$.

This view is supported by the fact that when diferro-nonacarbonyl is heated to 100° C. in a tube filled with carbon dioxide and fitted with a small mercury index manometer, at first the solid is decomposed with formation of a green liquid without any appreciable development of pressure, but as the heating is continued, pressure is gradually developed, iron is formed, and the green colour disappears.

When heated to 100° C. with carbon monoxide under a pressure of 75 atmospheres, the solid is at once converted into liquid iron pentacarbonyl and no green colour is produced. This shows that the re-combination of carbon monoxide with the diferro-nonacarbonyl is favoured by pressure, and the formation of the green compound usually produced is prevented in this way.

These facts are here re-stated and supported by further evidence in order that they may be compared with the results of experiments on the action of heat on diferro-nonacarbonyl in the presence of solvents.

When the crystals of diferro-nonacarbonyl are heated with a solvent such as ether or toluene, change begins at a much lower temperature, below 60° C., and the liquid acquires a dark green colour (as stated above, the green colour is developed slowly, even at 46° C.). When enough of the solvent is present, the whole of the solid dissolves and no iron or other solid substance is produced; the solution has such an intense colour that it is opaque, except in very thin layers.

It is clear, therefore, that we have here a different reaction to deal with.

The green solutions, on exposure to light, lose their colour and deposit the orange crystals of diferro-nonacarbonyl and a small quantity of a black solid.

By carrying out experiments in a closed tube filled with inert gas and fitted with a mercury manometer, it was shown that no change of pressure was caused by the action of heat or diferro-nonacarbonyl; hence no gas can have been evolved. Long continued heating, however, causes a disappearance of the green colour, and slight pressure is developed.

Similar results were obtained when benzene, petroleum ether, brombenzene, or iron pentacarbonyl was used as solvent.

When pyridine, alcohol, acetone, or acetonitrile was used as solvent, the solution obtained was not green, but

* A Paper read before the Royal Society, January 24, 1907.

some shade of red or brownish red, but again no gas was evolved.

When nickel carbonyl was used as solvent, the solution obtained was yellow, with only the faintest trace of green colour, a black solid was left, probably iron, and gas was evolved.

With chloroform, ferrous chloride was produced, so that the solvent had entered into the reaction; solid products were also produced when nitrobenzene was used as solvent, and with ethyl acetate or methyl aniline a greenish brown solution and a solid were produced.

The green solutions in toluene, ether, or petroleum ether were found in some cases to deposit beautiful green crystals, which, when separated, were found to contain iron and carbon monoxide and to re-dissolve in the solvent to give a green solution.

After numerous trials, the best conditions for the separation of the maximum amount of these crystals were found, and the following summarises the process used for their preparation.

The solid diferro-nonacarbonyl was sealed up in a tube, the air from which had been displaced by carbon dioxide, with toluene in the proportion of 1 grm. of the carbonyl to 20 cc. of toluene. The tube was then heated gradually, with occasional shaking, to about 95° C., and kept at that temperature until all the reddish yellow solid had disappeared, the tube being meanwhile shaken from time to time. If shaking is omitted or if the tube be heated to too high a temperature or for too long a time, a quantity of dark coloured powder is formed, but with care this may be almost entirely avoided.

The tube is then allowed to cool slowly, when fairly large crystals of the green compound separate from the solution and, after washing with the solvent and drying in a desiccator, were used for analysis.

The yield of the green crystals obtainable is only about 20 per cent by weight of the diferro-nonacarbonyl used.

The carbon monoxide was determined by combustion, care being taken to heat the boat long enough to oxidise any carbon that may have been retained in the iron. In this case the iron almost entirely remains in the boat, and, in some cases when there was no observable loss, good determinations of the percentage of iron were obtained by weighing the ferric oxide; in other cases there was obviously a loss, indicated by deposition of iron on the combustion tube near the boat, and the percentage of iron was low. Independent determinations of the iron were made by decomposing a weighed quantity of the crystals with nitric acid and igniting.

The following results were obtained by these methods:—

	Grm.		Grm.		Grm.	
1.	0·1078	gave	0·1118	CO_2 and	0·0513	Fe_2O_3.
2.	0·1214	,,	0·1258	,,	0·0442	,,
3.	0·1744	,,	0·0845	Fe_2O_3.		
4.	0·1828	,,	0·0868	,,		

	Found.	
	CO.	Fe.
1.	66·1	33·3
2.	65·9	—
3.	—	33·9
4.	—	33·2
$Fe(CO)_4$ requires	66·66	33·33

The compound is, therefore, *iron tetracarbonyl* or some polymer of this.

The decomposition of diferro-nonacarbonyl in presence of solvents such as toluene and ether is probably to be represented by the equation $Fe_2(CO)_9 = Fe(CO)_5 + Fe(CO)_4$.

Further evidence in support of this was obtained by carrying out the decomposition in tubes filled with carbon dioxide and fitted with a mercury manometer. No change of pressure was produced by the decomposition. On exposing the tubes, after heating and now containing a green solution, to light, the orange crystals of diferro-nonacarbonyl were deposited and pressure was produced, showing that during the action of heat iron pentacarbonyl has been produced.

Iron tetracarbonyl crystallises in short, dark green, lustrous prisms, the density of which was determined by the flotation method in a mixture of ethylene dibromide and alcohol, in both of which the compound is almost insoluble and was found to be 1·996 at 18° C.; the molecular volume is therefore 84. If we suppose that a molecule of $Fe_2(CO)_9$ (molecule volume 174) decomposes into a molecule of solid iron pentacarbonyl (molecule volume 128) and a molecule of the new iron tetracarbonyl, 174 volumes become 212 and there is consequently an expansion of 28 volumes, or about 16 per cent.

Iron tetracarbonyl is a substance of remarkable stability. On heating to about 140° to 150° C. it decomposes into carbon monoxide and iron. When heated under a pressure of 150 atmospheres of carbon monoxide it underwent no visible change until a temperature of 129° C. was reached, and then only turned slightly brown; it was not found possible to re-convert it into iron pentacarbonyl.

Reactions of Iron Tetracarbonyl.

The compound is not attacked by a concentrated solution of hydrochloric acid even on boiling; it is attacked by cold concentrated nitric acid, but only by concentrated sulphuric acid when heated. In the last case carbon monoxide and *ferrous* sulphate are produced. Aqueous solution of alkalis, whether hot or cold, had only a very slight action on the compound.

Molecular Weight.

Iron tetracarbonyl is soluble in many organic solvents, to which it imparts an intense colour; as it appeared to be decidedly soluble in benzene, it was thought that a molecular weight determination might be made by the cryoscopic method.

On examining the solubility, however, it was found to be small, only about 4 per cent in benzene and much less in acetic acid and alcohol.

Attempts were, however, made to determine the molecular weight, and proved definitely that the molecular weight must be very high.

For instance, a solution of 0·031 grm. of the compound in 12·88 grms. of benzene had a freezing point only 0·003° C. below that of the solvent.

Now if the molecule were $Fe(CO)_4$, (168) the depression of freezing point should be 0·076° C., so that the molecule would appear to be of the order of $\{Fe(CO)_4\}_{20}$, or, at any rate, the compound is a polymer consisting of many $Fe(CO)_4$ units.

Behaviour of Iron Tetracarbonyl towards Solvents.

Iron tetracarbonyl dissolves in benzene, toluene, petroleum ether, ether, acetonitrile, ethyl acetate, methyl and ethyl aniline, acetone, nickel carbonyl, and iron pentacarbonyl to give solutions of a dark green colour.

It is much less soluble in ethyl acetate and ether than in the hydrocarbons and carbonyls.

The solutions in the above solvents are all stable to heat at 100° C. for short periods, but the colour gradually disappears and iron is deposited if the heating be long continued. This decomposition is quickly completed at 140° C.

The iron tetracarbonyl can be re-crystallised easily from toluene, petroleum ether, or nickel carbonyl, when due care is taken to prevent oxidation, to which the solutions are very sensitive.

Pyridine, on the other hand, dissolves iron tetracarbonyl quickly and gives a green solution, which on standing for a few minutes turns red, which change of colour is brought about rapidly by warming.

Alcohol behaves similarly; only a faint green colour is obtained, as the substance is very sparingly soluble in alcohol; this solution becomes red on boiling. Solutions of the iron tetracarbonyl in the solvents, in which it forms

green solutions when mixed with pyridine in sufficient quantity, turns red on standing.

It is probable, therefore, that the iron tetracarbonyl when dissolved in pyridine exists in a different molecular state from that in which it exists in the green solutions, that is, it is dissociated into simpler molecules or is combined with the solvent. The same is true of solutions in alcohol. Now it was found that acetonitrile and acetone also gave red solutions instead of green when heated with the diferro-nonacarbonyl. Presumably the iron tetracarbonyl is present in these solutions in the same molecular state as in the pyridine solutions, but the effect of these solvents is only strong enough to bring about the conversion of iron tetracarbonyl into this state at the moment of its formation and not at a later stage.

It is noteworthy that iron tetracarbonyl dissolved in either nickel carbonyl or iron pentacarbonyl gives a green solution; hence, it follows that this solid iron tetracarbonyl is different from the hypothetical $Fe(CO)_4$, which it was suggested in our former communication (*loc. cit.*, p. 576) was the first product of the action of light on iron pentacarbonyl, and which then combined with this to form $\{Fe(CO)_3Fe(CO)_4\}$ or diferro-nonacarbonyl.

The green solutions of iron tetracarbonyl exhibit a characteristic absorption band in the yellow, while the red solutions show no selective absorption.

Action of Light on Iron Tetracarbonyl.

The green solutions gradually lose their colour on exposure to light, and a metallic looking solid, probably iron, is deposited. The change is very slow and the solutions were too dilute to allow of the detection of evolved gas with certainty: a small amount of a reddish solid, probably ferric oxide, was frequently observed, which was due to oxidation by traces of dissolved oxygen.

The red solution in pyridine appears to be quite stable to light; no change can be observed after long exposure.

A REVISON OF THE ATOMIC WEIGHT OF MANGANESE.*

By GREGORY PAUL BAXTER and MURRAY ARNOLD HINES.

(Continued from p. 103).

Purification of Materials (continued).

Manganous Chloride. — Two samples of manganous chloride were prepared. Sample B corresponded in its purity to Sample B of manganous bromide, since both were made by dissolving the same specimen of manganous carbonate. The solution of the carbonate in hydrochloric acid, which had been distilled with a quartz condenser, was evaporated to dryness in a quartz dish, and was heated to 200° in an electric oven. Then the filtered aqueous solution was evaporated to crystallisation in a platinum dish, and the first crop of crystals was twice re-crystallised (Sample B_1). The mother-liquors also yielded a crop of thrice re-crystallised salt (Sample B_2).

The mother-liquors of the manganous nitrate of Samples B and D were combined and re-crystallised six times, three times in glass and three times in platinum, and from this pure nitrate Sample E_1 of manganous chloride was prepared as above.

Hydrobromic Acid.—Commercial bromine was freed from chlorine by twice converting the bromine into hydrobromic acid by means of thoroughly washed hydrogen sulphide and water, and heating the hydrobromic acid, after distillation, with re-crystallised potassium permanganate. The bromine was thus twice distilled from a bromide, the bromide in the second distillation being almost free from chloride. Iodine was eliminated by boiling the hydrobromic acid in each case with a small quantity of permanganate and rejecting the bromine set free. A portion of the final product, when converted into ammonium bromide by means of ammonia, and added to a solution of 3·46875 grms. (in vacuum) of pure silver, yielded 6·03855 grms. (in vacuum) of fused silver bromide, whence the ratio of silver to silver bromide is 57·443, while 57·445 is the value to be expected (Baxter, "A Revision of the Atomic Weight of Bromine," *Proc. Am. Acad.*, 1906, xlii., 201).

By treating this bromine, covered with water, with washed hydrogen sulphide, hydrobromic acid was again produced. The solution was boiled, after mechanical separation of the greater part of the free sulphur and bromide of sulphur, and was then filtered. In order to remove the sulphuric acid produced during the action of the bromine upon the hydrogen sulphide, the hydrobromic acid was first distilled. Then it was diluted, and a small quantity of re-crystallised barium hydroxide was added to precipitate last traces of sulphuric acid. The slight precipitate of barium sulphate was collected upon a filter, and the acid was three times distilled with rejection of the first and last portions, with a glass retort and condenser. Finally the acid was once distilled with the use of a quartz condenser. The product of the final distillation was collected in quartz vessels, and was used immediately for dissolving the manganous carbonate. That this acid was free from solid impurities, such as alkalis and silica, was shown by evaporating 30 cc. in a weighed platinum crucible. No weighable residue remained after the crucible had been heated to very dull redness.

Hydrochloric Acid.—The "chemically pure" acid was boiled for some time, after the addition of a small quantity of potassium permanganate. Then it was twice distilled in glass, the middle portion only being collected, and finally once in quartz shortly before use.

Nitric Acid.—This acid was twice distilled, all but the last third of the distillate being rejected in each distillation. This acid gave no test for chloride in a nephelometer.

Silver.—Five different specimens of silver were employed, a portion of each one of which had already been used in an atomic weight research, and had been shown to be of the highest grade of purity. Two of these specimens, Samples H and J, were used in an investigation upon the atomic weight of iodine by one of us (Baxter, *Proc. Am. Acad.*, 1905, xli., 78). Sample H was prepared from silver nitrate which had been seven times re-crystallised from nitric acid, five times re-crystallised from water, and finally precipitated with ammonium formate. Sample J was precipitated once as silver chloride, electrolysed once, and finally precipitated with ammonium formate. Sample K was employed in our investigation upon the atomic weight of cadmium (Baxter and Hines, *Journ. Am. Chem. Soc.*, 1905, xxvii., 225). This sample was thrice precipitated as silver chloride, and once electrolysed. Sample L was precipitated once as chloride, once as metal by ammonium formate, and was once electrolysed. This sample has been used in the analysis of cadmium bromide (Baxter, Hines, and Frevert, *Journ. Am. Chem. Soc.*, 1906, xxviii., 770). Sample M was prepared for an investigation upon the atomic weight of bromine, and had been twice electrolysed after a preliminary purification (Baxter, *Proc. Am. Acad.*, 1906, xlii., 207). Samples H, J, and L also were used in the latter research, and were found to give values identical with those obtained with Sample M. All five samples were finally fused in a current of pure hydrogen in a lime-boat. The fused lumps were cleaned with dilute nitric acid, cut into fragments either with a clean steel chisel and anvil, or with a jeweller's saw, treated with dilute nitric acid until free from iron, washed, dried, and finally heated to about 300° in a vacuum.

The Analysis of Manganous Bromide.

The method of analysis was essentially that already frequently employed in this laboratory for the analysis of metallic halides. Weighed portions of the halides, after fusion in hydrobromic or hydrochloric acid, were first

* From the *Journal of the American Chemical Society*, xxviii., No. 11.

titrated against weighed portions of pure silver. Then the precipitated silver salts were collected and weighed.

The apparatus used for the fusion of the manganous bromide in a current of nitrogen and hydrobromic acid gases, was used in the preparation of ferrous bromide by one of us (Baxter, *Proc. Am. Acad.*, 1903, xxxix., 246), and is a modification of apparatus used for a similar purpose in determinations of the atomic weights of cobalt (Richards and Baxter, *Proc. Am. Acad.*, 1897, xxxiii., 117), nickel (Richards and Cushman, *Proc. Am. Acad.*, 1897, xxxiii., 99), and uranium (Richards and Merigold, *Proc. Am. Acad.*, 1902, xxxvii., 378) in this laboratory. A mixture of air and ammonia was passed over heated rolls of copper-gauze, and the excess of ammonia was removed by means of sulphuric acid. The gas was then purified and dried in an apparatus constructed wholly of glass, with ground joints, which consisted of a tower filled with beads moistened with silver nitrate solution to remove sulphur compounds, two similar towers containing dilute sulphuric acid to eliminate last traces of ammonia, and two towers filled with granular fused potassium hydroxide to absorb moisture and carbon dioxide. The partially dried gas, after bubbling through pure bromine in a small flask, passed into a second flask containing hydrobromic acid in which washed red phosphorus was suspended to convert the bromine into hydrobromic acid. A U-tube, also containing red phosphorus and hydrobromic acid, removed traces of bromine which escaped reduction in the flask. Two additional U-tubes containing beads moistened with concentrated hydrobromic acid only, served to eliminate phosphorus compounds which, in the investigation upon ferrous bromide (*loc. cit.*), were found to accompany the hydrobromic acid if the phosphorous acid in the reduction was allowed to become very concentrated. Finally the mixture of nitrogen and hydrobromic acid gases was thoroughly dried, first by pure fused calcium bromide, and then by re-sublimed phosphorus pentoxide.

The manganous bromide, contained in a weighed platinum boat, was heated gently in a current of nitrogen, purified as above, and dried by phosphorus pentoxide, until the greater part of the crystal water was expelled, then strongly in a current of nitrogen and hydrobromic acid until fused. After the salt had cooled, the hydrobromic acid was displaced by nitrogen, and this in turn by air which had been passed over solid potassium hydroxide, concentrated sulphuric acid, and phosphorus pentoxide. As stated before, the purifying apparatus was constructed wholly of glass, in such a way that by means of stopcocks any one gas or mixture of gases could be employed, to the exclusion of the others. The boat was then transferred to the weighing-bottle in which it was originally weighed, and the stopper was inserted without an instant's exposure of the salt to moisture, by means of the bottling apparatus which has been frequently described in papers from this laboratory (Richards and Parker, *Proc. Am. Acad.*, 1896, xxxii., 59). The weighing-bottle was then allowed to stand in a desiccator near the balance case for some time before it was weighed.

Next the boat was transferred to a flask, and the salt was dissolved in about 300 cc. of the purest water. The weighing-bottle was rinsed, and the rinsings were added to the solution. Then the solution was filtered into the glass stoppered precipitating flask through a tiny filter to collect a trace of insoluble matter, and the filter-paper and residue were ignited in a weighed porcelain crucible.

From the weight of manganous bromide very nearly the requisite quantity of pure silver could be calculated. This silver was weighed out and dissolved, in a flask provided with a column of bulbs to prevent loss of silver by spattering, in distilled nitric acid diluted with an equal volume of water. After the silver was dissolved, the solution was diluted to twice its volume, and was heated until free from nitrous fumes. Then it was still further diluted until not stronger than 1 per cent, and was slowly added with constant stirring to the 1 per cent solution of manganous bromide in the precipitating flask. After having been shaken for some time, the solution was allowed to stand several days, one week in the case of Analyses 14 and 15, with occasional shaking, until the supernatant liquid was clear. Thirty cc. portions of the solution were then tested with hundredth-normal solutions of silver nitrate and sodium bromide in the nephelometer for excess of bromide or silver, and, if necessary, either standard silver nitrate or sodium bromide solution was added, and the process of shaking and testing repeated, until the amounts of bromide and silver in the solution were equivalent. If the solution was perfectly clear when tested, and contained no considerable excess of bromide or silver, the test solutions were discarded, since they contained only negligible amounts of silver bromide, otherwise they were returned to the flask, and a correction was applied for the silver bromide thus introduced.

As soon as the exact end-point of the titration had been found, about 4 centigrms. of silver nitrate in excess were added to precipitate dissolved silver bromide, and the flask was again shaken, and allowed to stand until clear. The precipitate of silver bromide was collected upon a weighed Gooch crucible after it had been washed with water by decantation about ten times. Next it was heated for several hours at 140°, then for two hours at about 230° in an electric air-bath, and, after it had cooled in a desiccator, it was weighed. In order to determine how much moisture was retained by the precipitate, in each case it was transferred as completely as possible to a clean porcelain crucible and weighed; then the salt was fused by heating the small crucible, contained in a large covered crucible, and again weighed. The fused salt was light yellow as a rule, showing that no appreciable reduction had taken place. The asbestos mechanically detached from the Gooch crucible, together with a minute quantity of silver bromide which occasionally escaped the crucible, was collected from the filtrate and wash-waters upon a small filter, the ash of which was treated with nitric and hydrobromic acids before weighing. Although the filtrates and first wash-waters were essentially free from dissolved silver bromide, the subsequent wash-waters usually contained a trace of silver bromide. The amount of dissolved salt was determined with the nephelometer by comparison with standard bromide solutions.

Several difficulties were met in carrying out the analyses. In the first place it proved difficult to wash the platinum boat absolutely clean. When rinsed with cold water only, and dried at 100°, the weight was in many cases a few hundredths of a mgrm. greater than before fusion of the bromide. Ignition to redness of the boat thus treated then produced a slight loss in weight. Rinsing with hot water reduced the gain in weight of the boat after drying but did not wholly prevent a slight loss on ignition. The cause of the variation was not discovered, hence it seems safer in the calculations to use the weight of the boat after drying. The total variation is so slight, however, that it scarcely affects the final result.

Two other difficulties arose from the fact that when a solution of a manganous salt, even as dilute as the filtrates from analyses, is filtered through filter-paper, in spite of long-continued washing a small amount of manganese is tenaciously retained by the paper. This was discovered from the fact that the asbestos residues always contained manganese. In Analyses 31 to 33 it was found possible to eliminate the manganese completely by washing the filter finally with 5 per cent hydrobromic acid. In two cases (Analyses 29 and 30) the residues were analysed for manganese, and were found to contain 0·00023 and 0·00057 grm. of Mn_3O_4 respectively.

The average of these two quantities is, however, larger than the total residue in some cases, hence this value can not be used to correct the previous analyses. In order to determine accurately the proper correction for this error, a solution containing manganous nitrate in the proportion in which it was usually contained in the filtrate of an analysis, was passed through filter-paper, and the filters were then washed as thoroughly as possible with water. The ash of

these papers invariably contained manganese, the weights of manganic oxide in several experiments being found to be 0·00018, 0·00011, 0·00006, 0·00018, and 0·00005 grm. with an average of 0·00012 grm. This quantity was subtracted from the weight of asbestos shreds in all cases except Analyses 31 to 33, where the paper was washed with hydrobromic acid.

The residue obtained by the filtration of the manganous bromide proved to contain manganese, and to be free from detectable amounts of platinum and silica. Probably this insoluble residue consisted chiefly of oxides of manganese, although prolonged fusion in hydrobromic acid failed to reduce materially the proportion of insoluble matter. The discovery of adsorption in the case of manganous nitrate led to the suspicion that at least a portion of this residue was due to adsorption of manganese compounds by the filter-paper. In order to test this point a solution of manganous bromide, containing about 5 grms. in 200 cc., after one filtration was again filtered through a second filter about 3 cm. in diameter. Filters of this size were used in filtering the manganous bromide solution in the analyses. This filter was then washed with water as thoroughly as in an analysis, and was ignited. The weight of manganic oxide obtained was 0·00008 grm. Two repetitions of the experiment yielded 0·00008 and 0·00010 grm. respectively. If, as is probable, the manganese is adsorbed, not as bromide, but as some basic compound, possibly as manganic hydroxide, the bromine would have remained partially, if not wholly, in the solution. In that case a suitable correction could be applied by subtracting from the weight of the residue the average of the quantities of manganese adsorbed in the above experiments. An attempt to prevent the difficulty by adding dilute sulphuric acid to the solution of manganous bromide did not diminish the extent of the adsorption. Hence a negative correction of 0·00009 grm. is applied to the residues in all cases.

(To be continued).

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 101).

Procedures and Notes.

Procedure 1.—If the substance is a solid, note its colour, odour, and texture; examine it with a lens to determine whether it appears to be heterogeneous, and, if so, note the appearance of its constituents. Note especially whether it is an alloy or a non-metallic substance. If the substance is an alloy, pass to P. 3. If the substance is not an alloy, to determine whether organic matter or water is present in it, heat gently at first, then strongly, about 0·1 grm. of the finely powdered substance in a hard glass tube (of about 0·6 cm. bore and 8 cm. length) closed at one end. Note whether the substance blackens, whether a tarry or aqueous deposit forms on the cold part of the tube, and whether a burnt odour is emitted. If organic matter is thus proved to be absent, pass to P. 3; if proved to be present, pass to P. 2.

If the substance is a solution in water or other volatile liquid, note its odour, test it with litmus paper, and evaporate just to dryness enough to yield a residue of about 1 grm. Test a small quantity of this residue as described in the preceding paragraph. Treat the remainder by P. 3 if organic matter is found to be absent; otherwise by P. 2.

Notes.

1. When a complete analysis in the wet way is to be made, it is usually not worth while to make a more extended preliminary examination in the dry way. The closed-tube test is, however, essential, in order to show whether organic matter or water is present; and incidentally it often furnishes other valuable information.

2. Certain kinds of organic matter, especially sugars and hydroxy acids, such as tartaric, citric, and lactic acids, prevent the precipitation of the hydroxides of aluminium and chromium in the subsequent analysis, and must therefore be detected and removed. Moreover, a large quantity of organic matter of any kind interferes with the execution of the analysis; for example, with the operations of solution, filtration, and evaporation. Alloys do not contain organic matter or water; and therefore the closed-tube test need not be applied to them.

3. The closed-tube test is a more satisfactory method of detecting organic matter than heating in an open vessel. Blackening, unless accompanied by a burnt odour or by the formation of a tarry deposit, is not due to organic matter. Copper, cobalt, and nickel salts may cause it, owing to the formation of the black oxides on heating.

4. It is usually desirable to determine whether water is a constituent of the substance, and, if so, whether it is present in large or small proportion. This can be done with a fair degree of delicacy by the closed-tube test, provided care be taken to keep the upper part of the tube cool during the first of the heating. Water may be present as so-called water of constitution, as in FeO_3H_3 or Na_2HPO_4; as water of crystallisation, as in $MgSO_4.7H_2O$; as enclosed water, as in some hydrated silicates like the zeolites, or as mother-liquor within crystals; and as hygroscopic moisture on the surface. Water of constitution may be expelled only at a fairly high temperature, while in the other forms it is seldom retained above 200°.

5. The closed-tube test may also furnish evidence of the presence of certain metallic and non-metallic elements when the yare present in considerable quantity. Thus all ammonium salts and mercury compounds are volatilised much below a red heat: the former give on the upper part of the tube a white sublimate; the chlorides of mercury also give a white sublimate; while most other mercury compounds give a grey one, consisting of minute globules of mercury, made visible by a lens or by rubbing with a wire. Uncombined As, As_2O_3, and As_2S_3 are also readily volatilised, forming black, white, and yellow sublimates respectively. Of the acid-forming elements or groups, free sulphur or a persulphide is shown by a sublimate of reddish brown drops, changing to a yellow solid on cooling, and accompanied by odour of SO_2; a moist sulphide, by the odour of H_2S; a nitrate or nitrite, by brown vapours of NO_2; free iodine or a decomposable iodide, by a black sublimate of I_2 and by its violet vapour; a sulphite, by the odour of SO_2; a peroxide, chlorate, or nitrate, by evolution of oxygen, recognised by its inflaming a glowing wood-splinter held in the tube; and a carbonate or oxalate, by the evolution of CO_2, recognised by its causing turbidity in a drop of $Ba(OH)_2$ solution.

6. If the substance to be analysed is a liquid, it is desirable to determine first how much, if any, solid substance is present in it; for enough must be taken for analysis to enable small quantities of the metallic elements to be detected. Moreover, if it is dissolved in a volatile organic solvent the latter is removed by evaporation.

Procedure 2.—If the closed-tube test (P. 1) has shown the presence of organic matter, powder, or cut into small pieces, 1 to 5 grms. of the substance (according to the quantity of organic matter present). Add to it in a casserole about 5 cc. H_2SO_4 (1·84); warm gently until the substance is well charred; cool; add slowly, with constant stirring under a hood, HNO_3 (1·42) until violent reaction ceases; digest for a few minutes on a steam bath,

* From the *Technology Quarterly*, xix., No. 3, September, 1906.

and then heat over a flame, keeping the dish moving, until the substance is thoroughly charred. Cool, again add HNO_3 as before, and heat until thick fumes of H_2SO_4 are evolved; cool somewhat, and add a little HNO_3. Repeat this process till the H_2SO_4 becomes light coloured and remains so when heated strongly.

Evaporate the remaining H_2SO_4 under a hood to about 1·5 cc. Cool and add carefully about 10 cc. water. If there is a residue, cover the casserole and boil the mixture (to extract slowly dissolving sulphates); cool, filter, and wash, first with H_2SO_4 (1·20) and then with a little water, rejecting the washings. (Residue, P. 5.) To the solution add a drop of HCl (1·12). (If a precipitate forms, add more HCl, but only as long as a precipitate continues to separate; filter, wash the precipitate, and test it for silver by P. 15). Dilute the solution to a volume of 40 cc. (Solution, P. 21).

Notes.

1. This method of destroying organic matter is of very general application, being effective even when such stable substances as paraffin are present. Organic matter can also be destroyed by ignition, but this has the disadvantages of volatilising certain elements, especially mercury and arsenic, and of making some substances very difficultly soluble. When the organic matter consists only of oil, as is the case with an oil paint, it may be better to extract it with ether, especially when it is desired to determine the proximate constituents of the substance.

2. The residue contains: any substances originally present that have not been attacked by HNO_3 or H_2SO_4, especially silicates; all the lead, strontium, and barium that may have been present in any form, since the sulphates of these elements are insoluble in dilute H_2SO_4; all the silica, since silicic acid is dehydrated and made insoluble by heating with H_2SO_4; some of the calcium, bismuth, antimony, and tin, when these elements are present in moderate quantity, since their sulphates (or oxides) are not readily soluble in dilute H_2SO_4; and substantially all of the chromium, since its sulphate is converted into the insoluble anhydrous form.

3. After the organic matter is destroyed, the solution is evaporated to about 1·5 cc. and the solution is finally diluted to 40 cc., in order that the concentration of the acid may be right for the subsequent H_2S precipitation.

(To be continued).

Combination of Carbon with Nitrogen in the Elementary State.—M. Berthelot.—Pure carbon, free from hydrogen, and containing no trace of the metals of the alkalis or the alkaline earths, does not combine directly with nitrogen to form the nitride of carbon, *i.e.*, cyanogen, under the influence of heat alone at any known temperature; neither the electric current nor the voltaic arc effects the combination between the elements. The specific odour and the traces of cyanides found in gases containing nitrogen when traversed by the arc current are due the impurities which are capable of forming acetylene—a gas which combines directly with free nitrogen by means of electricity to form hydrocyanic acid. It is difficult to obtain absolutely pure carbon; the experiments on the combination of carbon with nitrogen are best carried out with the diamond, or with purified graphite, and with nitrogen absolutely dry and contained in a vessel closed so as to exclude the entrance of hydrogen. An inverse method may be employed, starting with pure cyanogen and decomposing it by means of a series of electric sparks. The author found, by continuing this process for several hours and obtaining an abundant deposit of carbon, that there was no reaction between it and the pure nitrogen when all traces of other products had been removed.—*Comptes Rendus*, cxliv., No. 7.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, February 21st, 1907.

Prof. R. MELDOLA, F.R.S., President, in the Chair.

MESSRS. T. S. Patterson and E. G. Streimer were formally admitted Fellows of the Society.

The PRESIDENT announced that the Society had incurred a further loss by the death of Professor Henri Moissan, which occurred on February 20th, in Paris; the late Professor Moissan was elected an Honorary and Foreign Fellow Member of the Society on January 20th, 1898.

On behalf of the Executive Committee of the Coal Tar Colour Jubilee Celebration, it was stated by the Chairman, Prof. R. Meldola, that the Council of the Society had that afternoon accepted the marble bust of Sir William Perkin, which was to be placed in the rooms of the Chemical Society according to the decision of the public meeting at which the celebration was inaugurated.

It was further stated that the Council had received and acknowledged, in the name of the Society, an important addition to the Research Fund in the form of a contribution of £1000 from the Worshipful Company of Goldsmiths.

Certificates were read for the first time in favour of Messrs. William Robert Ball, B.Sc., 48, Cambridge Road, Thornaby-on-Tees; Alexander Thomas Cameron, M.A., B.Sc., Burtonhill, Malmesbury; Geoffrey Dodleston Hope, B.Sc., Ph.D., Heath Heys, Oxton; The Hon. Raymond Egerton Hubbard, Addington Manor, Winslow; Herbert Brooke Perven Humphries, B.Sc., 117, Avenell Road, Highbury, N.; James McConnan, M.Sc., Ph.D., Danehurst, Greenbank Drive, Liverpool; Percy Joseph Rhodes, Bridge House, Church; Sydney William Smith, B.Sc., 76, Norroy Road, Putney, S.W.; Nicholas Tarr, Lucton School, Herefordshire; William Scott Tebb, M.A., M.D., Sandfield, Putney Heath Lane, S.W.

It was announced that the following changes in the Officers and Council were proposed by the Council:—

As President—Sir William Ramsay, K.C.B., F.R.S.; *vice*, Prof. R. Meldola, F.R.S.

As Foreign Secretary—Dr. Horace T. Brown, F.R.S.; *vice*, Sir W. Ramsay.

As Vice-Presidents—Prof. J. J. Dobbie, F.R.S., and Sir Alexander Pedler, F.R.S.; *vice*, Dr. H. T. Brown, F.R.S., and Prof. H. B. Dixon, F.R.S.

As Ordinary Members of Council—Mr. G. T. Beilby, Dr. W. R. Hodgkinson, Mr. E. Grant Hooper, and Dr. H. R. Le Sueur; *vice*, Prof. W. Gowland, Mr. A. D. Hall, Dr. A. Lapworth, and Mr. J. E. Marsh, F.R.S.

Mr. E. Grant Hooper, Dr. H. F. Morley, and Dr. H. R. Le Sueur were elected Auditors to audit the Society's accounts.

A ballot for the election of Fellows was held, and the following were declared duly elected:—Alfred Frederick Allen, B.Sc.; George Bagley; Frank Baker, B.Sc; Henry Bassett, jun., B.Sc., Ph.D.; Frank Stanley Benton; Leslie Hamilton Berry, B.Sc.; John Trevor Cart, B.Sc.; John Christie, B.A.; George William Clough, B.Sc.; Taylor Cook; Colin Ernest Dall, B.Sc.; Francis Davidson; William Smith Denham, B.Sc.; Mohan Nath Kedarnath Dikshit; Frederick Alldis Eastaugh; John Edwin Farmer; George Fowles; Edward William Lanchester Foxell, B.Sc.; Percival John Fryer; William Howieson Gibson, B.Sc.; William Godden, B.Sc.; William Heber Green, D.Sc.; Christopher Maurice Walter Grieb, B.Sc.; Richard Higham; William Marrs Hooton, M.A., M.Sc.; William James Hoyten, M.R.C.S., F.R.C.P.; Francis Townshend Cunynghame Hughes; Arthur Vivian Hussey; Ernest Wilfrid Jackson; Victor George Jackson; Sidney James

Jennings, B.Sc.; Albert Theodore King, B.Sc.; George Lunan; Joseph Martin, B.Sc.; Charles Pask Matthews, B.Sc.; Louis Murgatroyd; Otto Oberländer, Ph.D.; Frederic George Percy Remfry, B.A., D.Sc; Robert Robertson, M.A., D.Sc.; Arthur Henry Salway, Ph.D., B.Sc.; Charles Schlienger, B.Sc.; William George Sewell, B.Sc.; Frederick George Shepheard, B.Sc.; Robert Low Smith; William Sandilands Templeton, M.A., B.Sc.; Richard Noel Garrod Thomas, B.A.; Maximilian Toch; William George Twiney, B.Sc.; Charles Rowlatt Watkins, B.A.; Robert Burt Wight, M.A., B.Sc.; William Henry Williams; Mark Arthur Wolff.

The Council has ordered the following Report to be printed in the *Proceedings* of the Society:—

Recommendations as to the Nomenclature of the Proteins.

It is well known that much confusion arises at the present time from the lack of any understanding, either here or abroad, as to the exact sense in which the various names applied to proteins (Proteinstoffe, Eiweisskörper, Albuminoids) and their derivatives shall be used. No little difficulty is created by the use of a term in different senses, as well as ambiguity of meaning in some cases. It appeared desirable, therefore, to lay down rules for the guidance of students and workers, at all events in this country, which would tend to promote some degree of uniformity of usage. It was obviously desirable to retain existing terms as far as possible, especially as it was clear that the time has not yet come to coin strictly systematic names, and that only provisional recommendations are desirable in the existing state of knowledge.

The following Report is the outcome of a prolonged consideration of the subject by a number of chemists and physiologists. The original Committee was called into being by the Physiological Society; its members were nominated by the two societies. The Report of the Committee was subjected to criticism, both by the Physiological Society and by the Publication Committee of the Chemical Society. At the instance of the latter body a number of chemists specially interested in the subject then took the matter into consideration in conjunction with a few representatives of the Physiological Society; finally, a draft Report embodying the conclusions arrived at was prepared by Drs. Halliburton and Hopkins, which was considered and amended at a meeting of the Publication Committee of the Chemical Society, at which the physiologists were present.

Recommendations.

I. The word Proteid—which is used in different senses in this country and in Germany—should be abolished.

II. The word Protein is recommended as the general name of the whole group of substances under consideration. It is at present so used both in America and Germany. It admits readily of the use of such derived words as protease and proteose. If used at all, the term Albuminoid should be regarded as a synonym of protein.

III. The sub-classes should be as follows:—

1. *Protamines.*—These are simple members of the group. They are exemplified by substances like salmine and sturine which have been separated from fish-sperm.

2. *Histones.*—These are more complex substances; this and the previous class probably pass gradually into one another. The class is exemplified by the histones separated by Kossel from blood corpuscles; precipitability by ammonia is one of their distinguishing features.

3. *Albumins.*—These are proteins of which egg-albumin and serum-albumin may be taken as typical examples.

4. *Globulins.*—These are proteins which differ from the albumins in solubility; they are more readily "salted out" of solution than the albumins. They are exemplified by serum-globulin and fibrinogen. The class should also include certain derivatives of globulins such as fibrin and myosin.

N.B.—The carbohydrate radicle separable in small quantities from any members of Classes 3 and 4 is probably not to be considered as a prosthetic group, as it is in the gluco-proteins (see below).

N.B.—It appeared advisable, especially from the teachers' standpoint, to introduce a general term to include proteins coagulable by heat (Classes 3 and 4); but a term likely to meet with general acceptance has not yet been suggested.

5. *Sclero-proteins.* This new word takes the place of the word albuminoid in the limited sense in which the majority of physiologists have been accustomed to use it. It includes such substances as gelatin and keratin; the prefix indicates the skeletal origin and often insoluble nature of its members.

6. *Phospho-proteins.* This class includes such substances as vitellin and caseinogen with its derivative casein. The prefix nucleo frequently used in relation to this class is incorrect and misleading.

7. *Conjugated Proteins.* These are substances in which the protein molecule is united to a "prosthetic group." The principal sub-divisions are:—

a. Nucleo-proteins.
b. Gluco-proteins (*e.g.*, mucin).
c. Chromo-proteins (*e.g.*, hæmoglobin).

8. *Derivatives of Proteins.*—Of these the products of protein-hydrolysis (a term preferable to proteolysis) are those which require special attention. These should be classified as follows.

Note.—Although mindful of the unfortunate fact that terms such as proteolysis fail to convey a meaning in harmony with that which is conveyed by the terms electrolysis and hydrolysis (on which they are moulded) of decomposition *by*, the Committee have not ventured to deal with the difficulty; they recognise, however, that the practice is one to be obviated, if possible (compare Armstrong, *Proc. Roy. Soc.*, 1904, lxxiii., 500).

a. Meta-proteins.—This term is suggested in place of albuminate (acid-albumin, alkali-albumin), which is objectionable because (1) these products are obtainable from both albumins and globulins, also (2) because the termination ate implies a salt.

b. Proteoses.—This term includes albumose, globulose, gelatose, &c. The sub-division of these into proto-, hetero-, deutero-proteoses, &c., and the various modifications of Kühne's original classification have been considered; the whole subject is, however, at present too unsettled for any final nomenclature of these sub-divisions to be proposed.

c. Peptones.—This term should be restricted to the further products of hydrolysis which differ from the proteoses inasmuch as they cannot be salted out from solution, and usually resemble them in giving the biuret test.

N.B.—It has been pointed out that certain vegetable products hitherto regarded as peptones do not give the biuret test. It does not appear possible to bring such exceptional substances into any general classification at present. The same difficulty in classifying arises in connection with certain other vegetable proteins; for instance, those which like gliadin are soluble in alcohol.

d. Polypeptides.—The majority of the polypeptides are synthetical substances. Some, however, have been separated from the products of protein-hydrolysis, and it is therefore advisable to include them in the present classification. They are products of cleavage beyond the peptone stage, and consist of two or more amino-acids in association; the majority of those hitherto prepared do not give the biuret test.

IV. The term caseinogen should be used for the principal protein in milk and casein for its derivative which is the result of the action of rennet.

V. The two principal proteins of the muscle plasma should be termed paramyosinogen and myosinogen; the term soluble myosin should take the place of v. Fürth's soluble myogen-fibrin; the term myosin should be restricted to the final product formed during *rigor mortis*.

Of the following papers, those marked * were read:—

*38. "*The Constitution of Hydroxyazo-compounds.*" By William Bradshaw Tuck.

Several workers have proved that the ethers of all hydroxyazo-compounds and the benzoyl derivatives of the *p*-compounds possess the azo-structure, but that the benzoyl-*o*-hydroxyazo-compounds have the quinone-hydrazone configuration.

Chemical methods, however, have failed to produce a unanimous opinion with regard to the constitution of the free hydroxy-compounds.

As the absorption spectrum for azobenzene has been shown to be very different from that characteristic of quinones, several of the hydroxyazo-compounds were examined spectrographically.

The absorption spectra of the *p*-hydroxy-compounds agree extremely closely with those of their derivatives; further, hydrochloric acid produces the same very characteristic change in the spectra of the phenolic substances and their ethyl ethers. This proves that the constitution in the two cases is similar; that is, the free hydroxy-compounds are in the azo-form. The ethers of *o*-compounds also agree with the *p*-compounds, but the benzoyl derivatives are similar to benzoquinonebenzoylphenylhydrazone. The absorption spectra of all the azo-derivatives examined confirm the hypothesis previously put forward for the colour of azobenzene (*Trans.*, 1906, lxxxix., 982).

Discussion.

Dr. Hewitt agreed with Mr. Tuck that in the case of the *p*-hydroxyazo-compounds, the free substances, their ethers and esters were all of the azo-phenolic type, but was uncertain whether a solution of these substances in concentrated hydrochloric acid really contained much hydrochloride, since the bases being very weak, must have suffered considerable hydrolytic dissociation.

The contention that the *o*-hydroxyazo-compounds and their benzoyl derivatives corresponded to quinone-hydrazones was based apparently on the observation of Goldschmidt and Brubacher that acyl anilides result on complete reduction of the acyl-derivatives of benzeneazo-*p*-cresol. This might, however, be equally well the result of a secondary reaction, since esters and primary amines normally react to give alcohols or phenols and acid amides. Against these equivocal results must be placed the positive evidence that on substitution these compounds behave as azophenols whether they belong to the para- or ortho-series.

The only other physical method hitherto adopted in the case of the hydroxyazo-compounds has been the application of cryoscopic determinations in non-hydroxylic solvents by Auwers and Orton, whose results indicate that the para-compounds are azophenols, and give no positive result for the ortho-substances.

Goldschmidt himself abandoned the idea that the *o*-hydroxyazo-compounds were quinone-hydrazones, and his observation that the acylated compounds of both series reduce to hydrazo-compounds which are insoluble in alkali distinctly points to acylation, with respect to oxygen, having taken place.

Dr. Lowry said that Oddo's theory of "mesohydry" to which the author had referred was in many respects a reversion to Laar's theory of "tautomerism," since it postulated that a mobile hydrogen atom might be equally attached to oxygen and to nitrogen or carbon. If the hydrogen atom was capable under any conditions of settling in either of the alternative positions the phenomenon was not one of tautomerism, but a mere case of labile isomerism, which might become dynamic when the compound was liquefied with or without the addition of a catalyst. The separation of a single isomeride was a normal result of crystallisation, and, so far as he was aware, no genuine case of mesohydry or of tautomerism had yet been established. It was doubtful whether the hydrazo-compounds would prove to be an exception, although the possibility remained open that the crystals might, in certain cases, be isomorphous mixtures of two or more isomerides.

*39. "*The Influence of Solvents on the Rotation of Optically Active Compounds.* Part IX. *A New General Method for Studying Intramolecular Change.*" By Thomas Stewart Patterson and Andrew McMillan.

The influence of benz*aanti*aldoxime as a solvent on the rotation of ethyl tartrate was found to be very remarkable. A method of studying intramolecular change was described which had been applied in the cases of benzaldoxime, anisaldoxime, and ethyl phenylformylacetate.

*40. "*Displacement of Halogens by Hydroxyl.* I. *The Hydrolytic Decomposition of Hydrogen and Sodium Monochloroacetates by Water and by Alkali, and the Influence of Neutral Salts on the Reaction Velocities.*" By George Senter.

By varying the initial concentration within fairly wide limits, it was shown that the hydrolytic decomposition of monochloroacetic acid by hot water according to the equation $CH_2Cl\cdot CO_2H + H_2O = OH\cdot CH_2\cdot CO_2H + HCl$ is strictly unimolecular up to N/2 solution; the reaction velocity is somewhat retarded by hydrochloric acid, but is not affected by sodium chloride. The conclusion is drawn that water and the undissociated acid are the reacting substances; if an intermediate compound is formed, it is the rate at which it breaks down into glycollic and hydrochloric acids which is measured.

The decomposition of sodium chloroacetate by water is strictly unimolecular in dilute solution, but in solutions more than 0·1 molar, the velocity increases more rapidly than the concentration. The reaction is retarded by neutral salts. Potassium and barium chloroacetates undergo decomposition at the same rate as the sodium salt.

The interaction of sodium chloroacetate and N/10 sodium hydroxide, according to the equation $CH_2Cl\cdot CO_2Na + NaOH = OH\cdot CH_2\cdot CO_2Na + NaCl$, proceeds only about ten times more rapidly than the corresponding change in aqueous solution under equivalent conditions. The reaction velocity in the presence of alkali is accelerated, and to the same extent, by such neutral salts as sodium chloride, sulphate, and nitrate in equivalent solution.

On the basis of these results and of the previous observations of Arrhenius, the hypothesis put forward by R. J. Caldwell (*Proc. Roy. Soc.*, 1906, A, lxxviii., 272), according to which the accelerating influence of neutral salts on reactions in which acids (and alkalis) exert a catalytic action is ascribed to the withdrawal of water by the salt, and consequent concentration of the reacting substances, was criticised. It is considered that the effect in question is due to the action of the ions of the salt on H′ and OH′ ions.

Discussion.

Dr. Senter, replying to Dr. E. F. Armstrong, said that in his experiments, as in those of Arrhenius quoted in the paper, the ratio of alkali and acid respectively to water was constant, except for the slight differences in the amounts of water displaced by equivalent quantities of the neutral salts employed; that these differences did not amount to more than about 1 per cent of the total volume, and were therefore negligible in comparison with the magnitude of the neutral salt effect. Moreover, it did not seem quite justifiable to conclude from the results of experiments with sucrose, the solution volume of which is large and remains unaltered on dilution, that solutions for comparison should in all cases be prepared by adding a definite weight of the solute to a definite weight or volume of the solvent (H. E. Armstrong, *Proc. Roy. Soc.*, 1906, A, lxxviii., 264); in particular, salts which in certain dilutions have a negative solution volume seem to present difficulties from this point of view.

"41. "*The Interaction of Ammonium Salts and the Constituents of the Soil.*" By ALFRED DANIEL HALL and CONRAD THEODORE GIMINGHAM.

As it has been observed that an acid reaction develops in soil which has been repeatedly manured with ammonium salts, the authors have re-examined the action of ammonium salts on the chief constituents of soil. Solutions of various strengths, N to N/100, of ammonium sulphate, chloride, or other salt were shaken for twenty-four hours with silica, clay, calcium carbonate, and humus respectively, and the composition of the resulting solution was determined.

With silica, there is no action. With clay, a double decomposition takes place between the ammonium salt and zeolitic bodies in the clay, ammonium being withdrawn from solution and replaced by equivalent quantities of calcium, magnesium, and potassium. With varying strengths the reaction can be represented by the equation—

$$\frac{(\text{Ammonium withdrawn from solution})^a}{\text{Ammonium remaining in solution}} = K,$$

as long as the clay is in excess. If the clay is not in excess, it can only take up a fixed amount of ammonium whatever the strength of the solution. No acid reaction is produced, and there is no adsorption of the salt as a whole.

With calcium carbonate, the reaction does not proceed far, and the extent may be represented by an equation of similar form. With natural humus from various sources, the reaction is similar to that with clay; other bases, chiefly calcium, are displaced by ammonium; there is no development of acidity and no adsorption.

The acid reaction observed in the field is thus not due to inorganic causes; a biological origin has been found.

(To be continued).

PHYSICAL SOCIETY.

Ordinary Meeting, February 22nd, 1907.

Prof. J. PERRY, F.R.S., President, in the Chair.

A PAPER on "*Transformer Indicator Diagrams*" by Prof. T. R. LYLE was read by Prof. F. T. TROUTON.

The term "transformer indicator diagram" has been applied by Professor Fleming to any series of periodic curves which give the forms, relative phase positions, and magnitudes of the waves of current and E.M.F. on both the primary and secondary sides of a transformer when working. Such diagrams have been obtained by many investigators in different ways, but by none of the methods hitherto used has it been possible to determine directly and independently either the wave of magnetic flux F in the core, or the wave of magnetising-current turns usually represented by the vector sum $n_1C_1+n_2C_2$. It is shown in the paper that the integral $\int(n_1C_1+n_2C_2)dF$ for one cycle is equal to the total iron loss per cycle, and the advantage of being able to determine both $n_1C_1+n_2C_2$ and F directly and accurately is apparent. By means of the wave-tracer designed by the author not only can the E.M.F. and current waves be accurately determined, but also the wave of magnetic flux pulsating in the core of the transformer, and in addition the magnetising current wave, $n_1C_1+n_2C_2$ can be obtained with the same accuracy as any of the other quantities. The author has already shown that if a periodic current C flows in the primary of a pair of coils whose mutual induction is M, and if the secondary be joined through a suitably arranged commutator, which commutes twice a second, to a large resistance r and thence to a galvanometer, there will be a steady deflection γ which is connected with the instantaneous value of C of the current at the instant of commutation by the relation—

$$MC = \frac{\lambda r T}{4}\gamma;$$

where λ is the reducing factor of the galvanometer and T the period. In the present paper the author uses a triad of coils, two of which (p_1 and p_2) serve as primaries and the third as a common secondary, S. If M_1 be the mutual induction between p_1 and S, and M_2 that between p_2 and S, and if the current C_1 circulates in p_1 while C_2 circulates in p_2 and the secondary S is connected through a resistance to a galvanometer, then—

$$n_1C_1+n_2C_2=\frac{\lambda r T}{4M}\gamma;$$

where $M_1/n_1=M_2/n_2=M$. By suitably adjusting M_1 and and M_2, therefore, the vector sum $n_1C_1+n_2C_2$ is proportional to γ. The paper describes tests with a transformer at no load, full non-inductive load, and full inductive load. New methods of comparing mutual inductances and of measuring mutual and self-inductances are given in the paper.

Mr. W. DUDDELL said the paper was an interesting and important one, and congratulated the author upon the ingenious double mutual induction method by which the vector sum $(n_1C_1+n_2C_2)$ was determined electrically. In the paper the core loss was nearly constant for no load and full load, but the author had used an E.M.F. wave which was practically a sine curve. He suggested that experiments should be carried out using distorted E.M.F. waves such as occur in many generators and transformers.

Mr. A. CAMPBELL remarked, in respect to the title of the paper, that it seemed a wanton confusion of nomenclature to use in this connection the term "indicator diagram" which had such a definite and accepted meaning in mechanics; we might as well talk of hysteresis loops as "iron indicator diagrams." Prof. Lyle's methods were interesting, particularly that for obtaining the curve of effective ampère turns $(n_1C_1+n_2C_2)$ by the use of a double mutual inductance which performed the vector addition. The author has wisely kept the mutual inductance small: without that condition the double air-core transformer might alter C_1 and C_2. It would probably be better to split it up into two separate pairs or coils. The setting of the ratio of the mutual inductances on the triple coil could be more easily done by Maxwell's null method, which was perfectly applicable to a pair of secondaries having a common primary. If various values of n_2/n_1 had to be dealt with, the two primary coils might be fixed at right angles and the secondary mounted so as to be capable of rotation with regard to the primaries in order to allow of variation in the ratio M_2/M_1. In connection with Prof. Lyle's methods of determining inductances by the help of the wave-tracer, the somewhat similar method of Dr. E. B. Rosa might be mentioned. It was interesting to see the actual hysteresis loops given; a comparison of these with ballistic tests on the same transformer would add valuable information.

Mr. A. RUSSELL said that the author's results proved that to a first approximation the magnetising force acting on the core followed the same law and had the same amplitude at all loads. This theorem was the starting point in the ordinary engineering theory of the transformer, but this was the first time that a careful experimental proof for a particular case had been given. The magnetic leakage in the transformer experimented on must have been very small. The formula—

$$\int_t^{t+T}(n_1C_1+n_2C_2)\frac{dF}{dt}dt$$

only gave the energy absorbed per cycle when the magnetic leakage was negligibly small. In many commercial transformers it would not be safe to use this formula. The core-loss diagrams were interesting, but their value would have been greater if the transformer had been so constructed that the magnetic flux density was approximately

uniform over the cross section of the core. The internal diameter of the centre-hole iron stampings employed was only about half the external diameter, hence the magnetic flux to which the iron was subjected was almost twice as great at the inner as at the outer circumference. As the values of the permeability of the iron at these forces might vary widely, we could not tell the distribution of the magnetic flux. This prevented us from making calculations as to the hysteresis and eddy-current losses in the core. The complete solution of the transformer problem could not be obtained until we knew more about hysteresis. Apparently there were molecular "frequency changes" in the core, and any theory that would elucidate their action would be of great value to electricians. In this connection he referred to a paper read by the Chairman in 1892.

A paper by Prof. Bragg on "*Ionisation of Gases by α-Particles of Radium*" was read by the Secretary.

The present paper contains an account of further progress in the work of determining the relative amounts of ionisation produced by the α-particle of RaC in different gases and vapours. The view is discussed that the ionisation (i) is connected with the expenditure of energy (ϵ) of the α-particle by the expression $\delta i/\delta \epsilon = kf(v)$, where k is a constant for each gas which may be termed the specific ionisation in terms of air as unity, the determination of which for various gases has been attempted in the present paper, and $f(v)$ is a function of the velocity of the α-particle only. It is established that the total number of ions produced by the α-particles of RaC varies with the nature of the gas, and is for most compound gases and vapours examined about one-third greater than for air. The conclusion is drawn that the primary action of the α-particle is a sub-atomic one. The production of ions may be considered a secondary consequence which varies with the energy expended, the speed of the particle, and the nature of the molecule ionised. The stopping-power of a gas is more nearly an additive property of the atoms in the molecule than any other property except mass, and this is an effect quite apart from the proportionality of stopping-power to the square root of the atomic weight. For atomic weights below 30 the stopping-power divided by the atomic square root is abnormally low, an effect curiously similar to the case of atomic heats. There does not appear any evidence that the chance of an atom being ionised is dependent upon whether it is already ionised, that is occasionally the molecule may lose several ions.

Mr. F. Soddy, in a letter read by the Secretary, drew attention to the parallelism between the conclusion of the author that the same molecule may become ionised more than once, and that of Rutherford that the α-particle itself is doubly charged. The view that the charge carried by the gaseous ion was the same in all classes seemed to have been definitely rendered untenable by the results of the author. So also was the view that the energy expended in the production of an ion was independent of the nature of the gas and the same in all cases. The theoretical consequences of the work of the author were of the greatest importance, for it is inconceivable that the α-particle should be able to pass through matter in the manner it has been proved to do, if the matter in question and the α-particles consisted substantially of electrons. The suggestion made finally in the paper of the relation between the ionisation and production of hydrogen and oxygen by radium had also been made independently by Rutherford.

Dr. R. S. Willows said he could not agree with Mr. Soddy that the paper rendered untenable the hypothesis that all ions carried the same charge. He pointed out that the stopping-power of a gas obeyed a certain law down to atomic weights about 30, and said that this might have some relation to the fact discovered by Barkla that the secondary radiation produced by Rontgen rays followed a definite law down to atomic weights about 40.

FARADAY SOCIETY.

Ordinary Meeting, February 19th, 1907.

Dr. T. Martin Lowry in the Chair.

Mr. John B. C. Kershaw, F.I.C., read a paper entitled "*The Present Position and Future Prospects of the Electrolytic Alkali and Bleach Industry.*"

The paper opens with a brief historical review. The original patent of Charles Watt for the electrolytic production of sodium or potassium hydrate and chlorine compounds was taken out fifty-five years ago; but the earliest industrial experiments were made in the early eighties, and in 1889 a 200-H.P. plant was erected at Griesheim, using the "elektron" cell, in which the diaphragms are said to be made of cement. This cell is now used extensively on the Continent, and appears to work satisfactorily and economically.

In England the earliest industrial trials were made with an asbestos diaphragm cell at Snodland in 1891-92, and afterwards with a bell type of cell. These experiments led to the formation of the Electrochemical Company at St. Helens, but the works are now closed down. The Hargreaves-Bird and the Castner cells were patented in 1892-93; the Castner-Kellner Works were started at Runcorn in 1897.

In America a Le Sueur diaphragm cell was erected in 1892 and a Castner cell at Niagara in 1897-98.

The second part of the paper contains a list of the works now operating in Europe and America, summarising, as far as information is available, power used, type of cell and process employed, and products made. The totals show that about 55,000 H.P. are now being devoted to the production of alkalis and bleach by the electrolytic method, and that plant representing about 13,000 H.P. is lying in reserve. Assuming that all the plants are being worked to the best advantage, the production of 70 per cent caustic soda at present would be about 110,000 tons per annum, with an equivalent of 231,000 tons of 35 per cent bleaching powder (2 tons of caustic and 4·2 tons of bleach per E.H.P. year).

In conclusion the future of the industry is discussed. Within the last few years the electrolytic method appears to have had a set-back. In the author's opinion the Le Blanc, electrolytic, and ammonia soda processes will continue to exist side by side. In the case of the first, alkali and bleach will be produced in diminishing quantities, but be compensated for by the sulphur derivatives which will yield the profits. The best of the electrolytic processes will gradually replace the Le Blanc method for the manufacture of chlorine products, and they will also produce metallic sodium and its derivatives. The ammonia soda process will continue to manufacture sodium carbonate and bi-carbonate, but it can never replace the other methods, until at any rate it succeeds in making chlorine products from its waste liquors.

Mr. W. Pollard Digby regretted that more information was not available regarding such points of detail as anode consumption, life and efficiency of diaphragms, &c., which would be of general use to to those engaged in the smaller electrolytic industries.

Mr. John Rhodin gave some interesting details regarding the early history of the electrolytic processes. He demurred from the author's statement that these were principally developed in Germany, and he attributed the failures in this country to over-capitalisation and reckless finance, and not to any lack of skill or knowledge on the scientific side. The future will largely depend on the cost of power production.

Dr. R. Seligman drew attention to some omissions in the author's list of works and products.

Dr. H. Borns, referring to the lack of information regarding diaphragms, thought that magnesite was being used successfully.

Mr. J. C. Richardson also added some interesting historical information. He favoured the "bell" type of cell in which an 84 per cent efficiency was possible.

SOCIETY OF CHEMICAL INDUSTRY.
(London Section).

Ordinary Meeting, March 4th, 1907.

Prof. C. V. Boys exhibited a Gas Calorimeter and demonstrated its working.

The following paper was read :—

"*Five Years' Experience in Measuring and Testing Producer Gas.*" By Prof. R. Threlfall, F.R.S.

The first part of the paper is devoted to a *résumé* of the principles and construction of the instruments employed in Pitot tube gas measurement. This is followed by a description of the "static" method of measuring gas density. An account is then given of the results of balancing the make and distribution of producer gas over a period of several years, this being illustrated by curves which show that an agreement within about 2 per cent can be attained in practice.

The next section of the paper is devoted to a discussion of the theory and practice of measuring pulsating streams of gas or air, such, for instance, as are produced by pumping by gas engines, or otherwise.

The subject of recording calorimeters is next dealt with, and some records are exhibited ; the calorimeter construction is not described, but there is a discussion of the general principles involved in the design, and a note on the testing of calorimeters.

The fourth part of the paper is devoted to the question of the determination of sulphur in producer gas, and it is shown that the Referee's test is less suitable for this purpose than a modification of Valentine's test, which is described. The discussion of this matter covers both the determination of sulphuretted hydrogen and of total sulphur, and it is shown that it is fatal to the sulphuretted hydrogen to employ a gas meter containing water—no matter how long it may have been in action.

The fifth part of the paper deals with testing producer gas for tar, and a proposal is made for a standard method of carrying out this investigation.

The best methods hitherto proposed and practised for the determination of the volume of gas produced per ton of coal, otherwise than by the author's meters, are considered critically, and some examples are given of the results of balancing on carbon, and on ammonia.

The paper ends with a note on the determination of producer temperatures by a system of thermo-couples, which are read by a potentiometer suitably divided to read direct and fed by a very large Clark or cadmium cell.

The paper is illustrated by many drawings and photographs.

NOTICES OF BOOKS.

The Cyanide Process of Gold Extraction. By James Park. Fourth English Edition. London : Charles Griffin and Co., Ltd. 1906.

The treatment of the cyanide process or gold extraction given in this book makes it equally suitable for the use of mining students and cyanide chemists, and from it a thoroughly sound knowledge of the most modern practical methods should readily be acquired, while the theory of the process is explained particularly clearly. Illustrative laboratory experiments are described in detail, and special attention is paid to the methods of control, testing, and analysis of solutions, many typical problems and exercises being worked out. In the fourth English Edition the treatment of silicious silver ore containing more or less gold is dealt with more fully than in the earlier editions, and the Rose process for the refining of gold and impure bullion by means of air or oxygen is also discussed, and, in fact, no recent improvement or development in cyanide practice appears to have been omitted.

Handbook on Petroleum. By Captain J. H. Thomson and Sir Boverton Redwood. Second Edition. London : Charles Griffin and Co., Ltd. 1906.

This handbook is designed for the use of inspectors under the Petroleum Acts, and for those who have the handling of petroleum and its products, and of calcium carbide. The occurrence and refining of petroleum are treated in outline only, but, on the other hand, methods of testing it are thoroughly explained, and suggestions for minimising danger in storing and transporting are made, so that the officers of local authorities will find the book of real practical value. A chapter, which is full of valuable advice, is given to the construction of oil lamps and the precautions which must be observed in order that their use may be attended by no danger. The second edition contains the new Order dealing with the keeping of calcium carbide, and an amended Order in regard to the keeping of petroleum spirit for motor-cars, besides other alterations and substitutions, and in an Appendix notes are given on the Petroleum Acts. The book is one which all who are in any way connected with the petroleum industry should not fail to acquire, for it is in every way practical and trustworthy.

Annuaire pour l'An 1907, Publié par le Bureau des Longitudes. ("Year-book for 1907, Published by the Longitude Bureau"). Paris : Gauthier-Villars.

This small volume contains in a compact form, besides copious astronomical statistics, detailed tables relating to geographical and meteorological subjects, and the weights and measures and monetary systems of the most important nations are compared. No physical or chemical data are given in this year's issue, whereas next year space will be found for them, and the geographical and meteorological information will be omitted ; this alternation of contents being continued in succeeding years. The issue for 1907 contains in addition to the tables some important articles ; one by M. Bouquet de la Grye discusses observations of the diameter of Venus, and the same author writes an account of the Fifteenth Conference of the International Geodetical Association, while a third paper, written by M. H. Deslandres, gives a comprehensive review of recent solar researches.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 7, February 18, 1907.

Certain Catalytic Reactions effected by means of Wood-charcoal. — Georges Lemoine. — The author describes experiments analogous to those of Abbé and Senderens upon the reducing and catalytic action of amorphous carbon in the presence of alcohols. Instead of animal charcoal, he employed bakers' wood-embers raised to a red heat, which has great absorbent power for gases. Ethyl alcohol, in presence of this charcoal heated by an electric current, is converted into aldehyde and hydrogen : $CH_3—CH_2OH = CH_3—COH + H_2$. The reaction between iodic acid and oxalic acid, to give carbonic acid and iodine, is greatly accelerated in the presence of this charcoal ; less by sugar-carbon, though very greatly by platinum-black.

Some Molecular Combinations of the Metallic Halides with Organic Compounds.—V. Thomas.—It is already a published fact that iodine has the power of attacking certain metals, particularly zinc, magnesium, and aluminium, in presence of liquids such as water, alcohol, and anhydrous ether. The author, in seeking a reason for this catalytic action, concludes that the explana-

tion does not lie in the property of the solvent to bring the iodine and the metal into intimate contact, since all the solvents for iodine do not bring about any reaction; and, on the other hand, a number of organic compounds of different functions are found to effect the combination. The following are found to exercise this catalytic action:—Fatty ketones, diketones, fatty nitriles. From the examples investigated, it appears that the part played by the catalyser is of a chemical nature, and the combination effected is due to the formation of an addition compound of iodine and the solvent. The existence of a combination of iodide-alcohol is very probable, and it is ascertained that acetones and nitriles combine readily with iodides. Some examples of experiments with magnesium and with aluminium to give the iodides in presence of these catalysers are added.

Research on Gold by the Wet Method in Auriferous Sands.—Albert Fournier.—The sand used by the author for a research on the gold contained in it was relatively very ferruginous, and it was necessary to avoid the solution of the gold with relatively large quantities of other metals—iron in particular—which would mask the presence of the gold. The addition of HCl and aqua regia was found in each case inefficient for extracting the gold, which, existing in the sand largely as oxides soluble in HCl, should theoretically have been thus separated, and this led to the expectation of the presence of manganese and the consequent formation of nascent chlorine as disturbing the course of events. Taking advantage of the presence of Mn, a further addition of 5 to 10 per cent MnO_2 was made and intimately mixed with the mineral matter, the mixture being then treated with pure HCl till a clear liquid was obtained. This was followed by decantation, washing with water, and warming of the mass on the water-bath to remove HCl, and finally precipitation with alcohol. The alcohol, containing such chlorides as it was capable of dissolving, was treated for hours with a continuous current of H_2S, very small quantities of metal being thus finally detected. The use of alcohol has many advantages over water, notably the precipitation of the sulphides in better agglomerated masses and the minimum deposit of sulphur. The insoluble sulphides are washed with boiling water acidified with HCl, re-dissolved in HCl, and evaporated to dryness. This process is repeated once or twice, and finally the evaporated residue is dissolved in water. This method of obtaining the precious metals is not so rich in result when applied to small quantities of mineral as the method of fusion with lead, but the advantage lies in its necessitating the estimation of a greater weight of gold, and in any case its results are more reliable.

The Reducing and Catalytic Properties of Amorphous Carbon in the presence of Alcohols.—J. B. Senderens.—The carbon employed in the author's experiments was the black animal extract, which can be obtained very nearly pure. With ethyl alcohol, the carbon caused by catalytic action a double action to take place:—(1) $CH_3.CH_2OH = CH_2 = CH_2 + H_2O$; (2) $CH_3.CH_2OH = CH_4 + HCHO$. With propyl alcohol the second effect was very slight; the gases resulting were in the following proportions:—Propylene, 87·8; carbonic oxide, 1·3; ethane, 9·5; hydrogen, 1·4 per cent. The main reaction is expressed thus:—$CH_3.CH_2.CH_2OH = CH_3.CH = CH_2 + H_2O$. These reactions take place at far lower temperatures than that at which any dissociation of the vapours of ethyl or propyl alcohol is obtained apart from the presence of carbon.

MISCELLANEOUS.

South-Western Polytechnic, Chelsea.—The Lord Alverstone, G.C.M.G., presents Prizes and Certificates to Students of Evening Classes and Day College on March 15th at 8 o'clock p.m.

Royal Institution.—On Thursday next, March 14, at 3 o'clock, Dr. C. W. Saleeby begins a course of two lectures on "Biology and Progress." The Friday Evening Discourse on March 15 will be delivered by Professor Lunge, on "Problems of Applied Chemistry"; and on March 22 by Professor J. J. Thomson, on "Rays of Positive Electricity."

MEETINGS FOR THE WEEK.

MONDAY, 11th.—Society of Arts, 8. (Cantor Lectures). "Romanesque Ornament," by F. Hamilton Jackson.

TUESDAY, 12th.—Royal Institution, 3. "The Visual Apparatus of Man and Animals," by Prof. William Stirling.

WEDNESDAY, 13th.—Society of Arts, 8. "Mediæval Stained Glass—its Production and Decay," by Noel Heaton.

THURSDAY, 14th.—Royal Institution, 3. "Biology and Progress," by Dr. C. W. Saleeby, F.R.S.E.

—— Society of Arts, 4.30. "The City of Madras," by Sir James Thomson, K.C.S.I., &c.

FRIDAY, 15th.—Royal Institution, 9. "Problems of Applied Chemistry," by Prof. George Lunge.

SATURDAY, 16th.—Royal Institution, 3. "Röntgen, Cathode, and Positive Rays," by Prof. J. J. Thomson.

ERRATUM.—P. 104, col. 1, line 25. *Read* "By Samuel Smiles and Thomas Percy Hilditch."

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BOTANY	V. H. BLACKMAN, M.A.
ZOOLOGY	H. W. UNTHANK, B.A., B.Sc.
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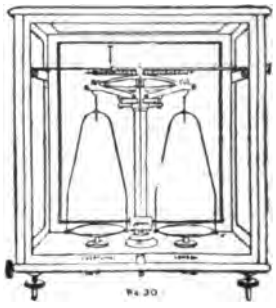

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THE CHEMICAL NEWS.

Vol. XCV., No. 2468.

A COMPARISON AND CRITICISM OF THE METHODS FOR THE DETECTION AND ESTIMATION OF COCOANUT OIL IN BUTTER.

By T. R. HODGSON, B.A. (Cantab.).

1. *The Reichert-Wollny Number.*—In these experiments the usual method was followed. Five grms. were hydrolysed and afterwards the volatile acids distilled, filtered, and titrated; the insoluble fatty acids were then dissolved in alcohol and titrated. The following results were obtained:—

	Reichert-Wollny number.	Cc. N/10 NaOH required for alcoholic solution.
Pure butter fat	27·6	2·5
90 per cent butter fat and 10 per cent cocoanut oil ..	25·7	3·1
80 per cent butter fat and 20 per cent cocoanut oil ..	24·4	3·8
50 per cent butter fat and 50 per cent cocoanut oil ..	19·3	6·4
Pure cocoanut oil	9·6	14·1

As will be seen, more than 10 per cent of cocoanut oil must be added to the butter fat before the Reichert-Wollny number is brought below the standard.

The increase in the number of cc. of N/10 NaOH does not correspond with the increase in the amount of cocoanut oil present in the sample.

It has been suggested that the ratio $\frac{\text{Insoluble acids} \times 100}{\text{Soluble acids}}$ should give a number—

For pure butter fat.. ..	between	10 and	15
For pure cocoanut oil ..	„	210 „	280

The ratios, calculated on the numbers given above, are—

Pure butter fat	9·0
90 per cent butter fat and 10 per cent cocoanut oil	11·8
80 per cent butter fat and 20 per cent cocoanut oil	15·6
50 per cent butter fat and 50 per cent cocoanut oil	33·1
Pure cocoanut oil	146·8

It will be seen that there is no regular increase in the number with increase of cocoanut oil.

I am of opinion that this method is absolutely untrustworthy as a quantitative experiment, especially as it is unable to detect 10 per cent or less of added cocoanut oil.

2. *Thorpe's Method* (*Analyst*, xxxi., p. 173).—Thorpe first proceeds as in the Reichert-Wollny method. He distils off 110 cc., filters, and titrates in the usual way; he then adds 110 cc. of water to the flask and distils off another 110 cc.; he cools and pours over the same filter and titrates the second filtrate; he then washes the apparatus with 50 cc. of alcohol and pours this over the filter, and then washes the filter with another 50 cc. of alcohol (90 per cent), slightly warmed, and finally titrates the alcoholic solution with N/10 NaOH and phenolphthalein. Thorpe's numbers are:—(See Table, next column).

Thus in Thorpe's numbers there is apparently no connection—or only a very slight one—between the increase in the number of cc. of N/10 NaOH solution required and the increase in the proportion of cocoanut oil; the average increase being 2·3 cc. for every 10 per cent of cocoanut oil present.

	Reichert-Wollny number.	Cc. N/10 NaOH required for— Second filtrate.	Alcoholic solution.
Butter fat	29·2	3·1	7·6
90 per cent butter fat and 10 per cent cocoanut oil	27·1	3·7	10·2
80 butter fat and 20 cocoanut oil	24·6	4·0	15·5
70 butter fat and 30 cocoanut oil	23·4	4·0	18·1
60 butter fat and 40 cocoanut oil	21·5	3·9	20·1
50 butter fat and 50 cocoanut oil	19·4	4·2	21·8
40 butter fat and 60 cocoanut oil	17·6	4·4	24·4
30 butter fat and 70 cocoanut oil	15·1	4·2	26·0
20 butter fat and 80 cocoanut oil	13·3	4·4	27·1
10 butter fat and 90 cocoanut oil	10·6	4·4	29·1
Pure cocoanut oil ..	8·0	4·0	34·0

The objection to this method is that, just at the point where it would be most useful (that is, between 10 and 20 per cent of cocoanut oil) the constant nearly doubles itself.

My own numbers differ considerably from Thorpe's.

	Reichert-Wollny number.	Cc. N/10 NaOH required for— Second filtrate.	Alcoholic solution.
Butter fat	28·0	2·7	3·3
80 per cent butter fat and 20 per cent cocoanut oil	24·9	3·3	12·0
70 per cent butter fat and 30 per cent cocoanut oil	22·4	3·6	13·4
Pure cocoanut oil ..	9·5	4·6	27·8

The number of cc. of N/10 NaOH required for the alcoholic solution in this case shows a rise of 3·4 for every 10 per cent of cocoanut oil on the average, but there is no regular increase.

Taking the number of cc. of N/10 NaOH required for the alcoholic solutions in the author's results, in the case of the mixtures of 20 per cent cocoanut oil and 80 per cent butter fat and 30 per cent cocoanut oil and 70 per cent butter fat, and comparing them with the numbers obtained for similar mixtures by Thorpe, one is struck by the fact that they would have to be returned as containing 15 and about 20 per cent of cocoanut oil, or a loss of 5 per cent and 10 per cent of cocoanut oil respectively; or, if the factor obtained from Thorpe's results is used, they would have to be returned as containing 33 and 44 per cent of cocoanut oil respectively, or an excess of 13 per cent in the one case and 14 per cent in the other.

This method is evidently useless as a means of estimating the percentage of cocoanut oil present in the sample, unless the analyst has a sample of the original pure butter in his possession.

As a means of detection of the presence of cocoanut oil the method has a certain amount of use, inasmuch as Thorpe says that the number of cc. of N/10 NaOH required for pure butter never exceeds 8·4; and therefore if any sample requires more than 8·4 cc., it points to adulteration.

3. *Iodine Absorption Method.*—These experiments were performed with Hann's solution of iodine bromide in glacial acetic acid, as this solution requires a much shorter time for complete saturation than Hübl's solution; but, on the other hand, the numbers obtained are usually somewhat higher than those obtained with the Hübl solution. The numbers obtained were as follows:—

Pure butter fat	40·3
80 per cent butter fat and 20 per cent cocoanut oil..	35·3
70 per cent butter fat and 30 per cent cocoanut oil..	31·7
Pure cocoanut oil	8·7

This method shows a more or less regular decrease of about 3 per cent for every 10 per cent of cocoanut oil added. Taking the highest iodine value for cocoanut oil 9·5 and using the factor 3, from the above results the calculated amounts of cocoanut oil are 14 per cent and 26 per cent, or a loss of 6 per cent of cocoanut oil in the one case and 4 per cent in the other.

4. *Saponification Number.*—The usual method was followed, the saponification with N/2 alcoholic potash and titration of the excess of potash with N/2 hydrochloric acid and phenolphthalein.

The saponification number is calculated as the number of grms. of KOH required to saponify 100 grms. of the sample. The numbers obtained were:—

Pure butter fat	22·6
80 per cent butter fat and 20 per cent cocoanut oil..	23·1
70 per cent butter fat and 30 per cent cocoanut oil..	23·3
Pure cocoanut oil	23·5

The numbers approximate so closely together that the method may be dismissed as practically useless.

5. *Extraction of Cholesterol or Phytosterol* (Foster and Reichman, *Analyst*, 1897, p. 131).—Fifty grms. of the sample were boiled for five minutes under a reflux condenser with two successive portions of 75 cc. each of 95 per cent alcohol; the alcohol was separated in a tap funnel, a piece of KOH was added to the mixed alcoholic solutions, which were then evaporated to dryness; the residue was then taken up with water and extracted with ether; the ether was then evaporated, and the residue dissolved in 95 per cent alcohol and allowed to crystallise.

Cholesterol crystallises in large plates and phytosterol in needles.

The phytosterol is very difficult to crystallise, and must be allowed to do so slowly.

Since cholesterol is only present in animal fats or oils and phytosterol only in vegetable, the presence of phytosterol may be taken as a proof of the admixture of vegetable oils, and it is said that when mixtures of cholesterol and phytosterol are crystallised, even when the cholesterol is in excess by 20 to 1, the form of the crystals leans towards that of phytosterol.

6. *Wigsmann and Reijst's Method* (*Zeit. Nahr. Genussen*, 1906, xi., 267—271).—Wigsmann and Reijst suggest the following method:—Five grms. of the fat are treated in the ordinary Reichert-Meissl method, and to the neutralised distillate they add 40 cc. of N/10 $AgNO_3$ solution; the precipitate is collected on a filter and washed until the filtrate amounts to 200 cc.; 50 cc. of N/10 NaCl are then added to the latter, and the excess of chloride is titrated back with the $AgNO_3$ solution, using potassium chromate as indicator.

The number of cc. of $AgNO_3$ solution used increased by one-tenth gives the first silver number.

Another 5 grms. are then saponified and distilled, and when 100 cc. have been collected, 100 cc. of water are added to the flask and the distillation continued; the addition of water is once more repeated; the distillates (300 cc.) are mixed and 250 cc. are neutralised, 40 cc. of N/10 $AgNO_3$ solution added, the precipitate collected and washed until the filtrate amounts to 350 cc.; 50 cc. of N/10 NaCl are then added and titrated back as before.

This number of cc. + one-fifth gives the second silver number. In the case of pure butter the second silver number is equal to the first silver number, and in the case of cocoanut oil the second silver number is greater than the first silver number.

This method is an excellent qualitative test, but quantitatively it is of no value, since the increase of the second silver number over the first silver number is extremely variable and apparently bears no relation to the amount of cocoanut oil present. Taking Wigsmann's and Reijst's own numbers, the increase of the second silver number over the first silver number varies indiscriminately from 0·25 to 4·3 in the presence of 5 per cent of cocoanut oil, and from 1·4 to 4·4 in the presence of 10 per cent of cocoanut oil.

Finally, the saponification number is of no practical value, either qualitatively or quantitatively. The Reichert-Wollny number may show some indication of the presence of cocoanut oil if the amount present in the sample is large. Wigsmann and Reijst's method is by far the best qualitative experiment, since it shows a difference between the two silver numbers in the presence of even as little as 5 per cent of cocoanut oil, but as a quantitative method it is of no value.

Thorpe's method is an excellent confirmatory test, as is also the extraction of phytosterol.

The only exact quantitative method is the iodine absorption, and I believe that the results obtained by the more general use of this method would be of much greater value than those obtained with methods of high theoretical importance, but which are at the same time of little or no value to the practical analytical chemist.

PREPARATION OF TITANIUM TETRACHLORIDE FROM RUTILE.

By H. R. ELLIS, B.Sc., F.C.S.

RUTILE was heated up to 1000° C. in a muffle furnace, and whilst red-hot suddenly plunged into cold water. This treatment rendered the substance so brittle that it was easily reduced to a fine powder in an iron mortar.

The dry powder was sifted through a fine sieve and heated to about 500° C. in the front part of the muffle furnace; whilst still hot it was mixed with a little less than half its own weight of fine aluminium powder in a Hessian crucible.

In order to start the reaction, a mixture of dry TiO_2 and Al powder was spread over the top and ignited by burning magnesium. The reaction proceeds steadily, and the whole of the rutile is attacked. The contents of the crucible were covered with a layer of magnesium as soon as the action commenced; this protected the hot titanium from contact with the air.

The bodies present after the reaction consisted of iron, titanium, silicon, and alumina. As soon as the contents of the crucible had cooled somewhat, its contents were transferred to a combustion tube and heated to redness in a steady current of chlorine, which was supplied from a cylinder and was passed through one wash-bottle containing strong sulphuric acid.

The end of the combustion tube was bent downwards slightly and passed into the bulb of a Wurtz flask, the side tube of the flask was closed with a $CaCl_2$ drying-tube. The titanium tetrachloride soon began to distil into the flask, whilst the iron chloride settled on the cooler parts of the tube; with a good sample of rutile the amount of iron chloride produced is very small; if the amount of iron present is large the tube must be made wider. No aluminium chloride should be produced, excess of aluminium not being used. The crude product was purified by distillation; the first distillate, consisting chiefly of chlorine and silicon tetrachloride, amounted to about one-fifth of the whole. The second portion was collected from 120—137° C., was again distilled, and finally distilled from a very small quantity of mercury, which retained the last traces of chlorine; the pure body distilled at 136° C.

Reaction of Aluminium Powder and Silica.

Since a fairly large amount of silicon tetrachloride was produced in the above preparation, it is quite evident that

aluminium attacks silicates or silica, producing silicon. Experiments were tried with various samples of silica in order to see how readily this reduction took place.

A mixture of pure dry sand and aluminium powder (quantities in accordance with the equation $4Al + 3SiO_2 = 2Al_2O_3 + 4Si$) was first employed. This would not react in the cold, even when a layer of magnesium was ignited on the top.

When this mixture was heated to about 500° C. in the furnace and again treated with magnesium, the reduction took place slowly and needed heat to proceed to an end.

A sample of kieselguhr was mixed with aluminium powder and similarly treated; this behaved in a similar manner, and the reduction took place slowly. A mixture of magnesium powder and kieselguhr reacted with great violence. The large heat development in the formation of alumina from rutile accounts for the easy reduction of the silica and silicates present.

Chemical Laboratory,
The Polytechnic. Regent Street, W.

A REVISON OF THE ATOMIC WEIGHT OF MANGANESE.*

By GREGORY PAUL BAXTER and MURRAY ARNOLD HINES.

(Concluded from p. 113).

The Analysis of Manganous Chloride.

The apparatus employed for the fusion of manganous chloride was very similar to that used in the fusion of the bromide. Hydrochloric acid gas was generated by dropping concentrated sulphuric acid into concentrated hydrochloric acid. The gas was freed from spray in a gas washing-bottle, and was dried in five towers filled with beads moistened with concentrated freshly boiled sulphuric acid. From the towers the gas passed into the bottling apparatus in which the salt was fused in a current of hydrochloric acid, and bottled in pure dry air as described above. This apparatus also was made wholly of glass with the exception of the air-drying powers which were closed with rubber stoppers. Since the salt was not heated in air no error could arise from this source.

In a few preliminary experiments the hydrochloric acid gas was passed finally over freshly sublimed phosphorus pentoxide, but this drying agent was subsequently eliminated since it was found to introduce volatile phosphorus compounds into the hydrochloric acid, and thus into the manganous chloride, if the latter was moist. The effect of this difficulty upon previous work in this laboratory in the case of the analysis of chlorides which were fused in a current of hydrochloric acid gas, has been discussed elsewhere, and has been shown to have been negligible (Baxter, Hines, and Frevert, *Journ. Am. Chem. Soc.*, 1906, xxviii., 779). In the same place it has also been shown that hydrochloric acid gas attacks sulphuric acid to so slight an extent that the latter may safely be used to dry the former.

Although at first sight it is to be expected that hydrobromic acid, if dried by means of phosphorus pentoxide, would act upon this substance in a way similar to the action of hydrochloric acid gas, it has been shown that no such difficulty exists if the hydrobromic acid is as dilute as in our work (*Journ. Am. Chem. Soc.*, 1906, xxviii.. 781), the maximum concentration attainable by passing nitrogen through bromine at ordinary temperatures, and then over phosphorus being not greater than 30 per cent by volume.

The principal point of difference between the analyses of manganous bromide and manganous chloride was occasioned by the greater solubility of silver chloride. This introduced no difficulty in the case of the titrations, although the opalescence in both nephelometer tubes was of course more marked at the end-point. In order to make the precipitation of the silver chloride more complete, however, a much larger excess of silver nitrate was necessary than in the case of silver bromide, about fifteen hundredths of a grm. being added in each analysis. Furthermore, the precipitate was washed at first with a solution of silver nitrate containing four hundredths of a grm. in a litre, although the final six washings were performed with water. The silver chloride dissolved in both filtrate and washings was determined by comparison as previously described. Here even the filtrate showed a trace of dissolved silver chloride.

In the case of manganous chloride also the extent of the adsorption of manganese compounds by the filter-paper was investigated by filtering a solution of the salt through a filter-paper, and, after thoroughly washing the paper, determining the residue after ignition. The correction for adsorption thus found, 0·00006 grm., is in some cases larger than the weight of the residue minus the loss in weight of the boat, owing possibly to the fact that not all the platinum lost by the boat is collected upon the filter-paper. At any rate the uncertainty introduced by applying the correction wherever possible is very small.

The filter upon which the asbestos shreds were collected was washed with warm dilute hydrochloric acid to eliminate adsorbed manganese compounds, so that no correction for adsorption is here necessary. This acid was then tested for silver chloride with the nephelometer, and if any was found it was added to the main weight of this substance.

In Analyses 32, 33, 34, 35, and 38 the silver nitrate was added to the manganous chloride, while in Analyses 36 and 37 precipitation was performed in the reverse fashion.

The possibility of the existence of manganic compounds in the salts was considered. In order to determine whether or not this was the case, one specimen of manganous chloride after fusion in hydrochloric acid was tested for manganic compounds by adding a solution of starch-paste and potassium iodide. No coloration resulted even after the addition of hydrochloric acid, although a trace of permanganate produced immediate coloration in the same solution.

The fused salts were pink in the case of both the chloride and the bromide, hence Forchhammer's statement that the pink colour of manganous salts is due to the presence of manganic compounds is incorrect (*Ann. Phil.*, N.S., 1821, i., 50).

It has already been shown that chlorides and bromides which have been fused and allowed to solidify in an acid atmosphere occlude none of the gas, for they give neutral solutions (Richards, *Proc. Am. Acad.*, 1893, xxix., 59; *Journ. Am. Chem. Soc.*, 1902, xxiv., 376; Richards and Baxter, *Proc. Am. Acad.*, 1899, xxxiv., 367; Baxter and Hines, *Journ. Am. Chem. Soc.*, 1905, xxvii., 227).

The Nephelometer.—The nephelometer employed for the estimation of slight opalescences has already been described in detail by Richards and Wells (*Am. Chem. Journ.*, 1904, xxxi., 235; 1906, xxxv., 510). All the precautions necessary for the accurate use of this instrument were carefully observed. The two tubes to be compared were always of the same size. The source of light in the nephelometer was so adjusted that tubes containing exactly equal amounts of precipitate gave identical readings. It was found advantageous to insert a plate of ground glass between the source of light and the test-tubes. In making up the test solutions, great pains were taken that the concentration of electrolytes in the two solutions and the conditions of precipitation should be as nearly as possible the same. Final readings were taken only after the ratio between the two tubes had become constant.

Vacuum Corrections.—In order to find accurately the vacuum corrections for manganous bromide and chloride, it was necessary to determine the densities of these two salts. The experiments were carried out exactly as described in our determinations of the specific gravities of

* From the *Journal of the American Chemical Society*, xxviii., No. 11.

The Atomic Weight of Manganese.

Series I.—$MnBr_2 : 2Ag$. (Ag = 107·930, Br = 79·953).

No. of analysis.	Sample of $MnBr_2$	Sample of Ag.	Wt. of $MnBr_2$ in vacuum (grms.).	Corrected weight of residue (grm.).	Change in weight of boat (grm.).	Weight of Ag in vacuum (grms.).	Weight of Ag added or subtracted (grm.).	Corrected weight of $MnBr_2$ (grms.).	Corrected weight of Ag (grms.).	Atomic weight of manganese.
1.	A_2	K	6·53738	0·00000	−0·00004	6·56772	−0·00017	6·53738	6·56755	54·962
2.	A_1	K	4·81026	0·00019	+0·00002	4·83243	−0·00005	4·81005	4·83238	54·957
3.	C_1	K	4·88124	0·00027	0·00000	4·90354	0·00000	4·88097	4·90354	54·960
4.	C_1	H	5·63234	0·00022	−0·00007	5·65833	−0·00020	5·63219	5·65813	54·964
5.	A_1	H	5·79927	0·00008	−0·00005	5·82610	−0·00010	5·79924	5·82600	54·963
6.	C_1	J	6·59033	0·00046	+0·00004	6·62051	−0·00010	6·58983	6·62041	54·957
7.	B_1	H	4·19917	0·00016	−0·00010	4·21809	+0·00030	4·19911	4·21839	54·967
8.	A_1	J	3·59834	0·00015	+0·00010	3·61478	0·00000	3·59809	3·61478	54·957
9.	B_1	J	5·16345	0·00019	−0·00008	5·18711	0·00000	5·16334	5·18711	54·965
10.	B_1	K	3·92230	0·00014	−0·00010	3·94021	+0·00021	3·92226	3·94042	54·959
11.	B_1	K	4·49181	0·00032	−0·00009	4·51220	+0·00030	4·49158	4·51250	54·953
12.	C_1	H	3·60099	0·00016	+0·00012	3·61746	−0·00010	3·60071	3·61736	54·960
13.	D_1	H	4·77414	0·00022	0·00000	4·79602	+0·00018	4·77392	4·79620	54·951
14.	D_1	J	3·57674	0·00015	−0·00001	3·59323	−0·00004	3·57660	3·59319	54·957
15.	D_2	H+J	5·69991	0·00026	−0·00007	5·72586	+0·00055	5·69972	5·72641	54·948
								Average		54·959

Series II.—$MnBr_2 : 2AgBr$. (Ag = 107·930, Br = 79·953).

No. of analysis.	Sample of $MnBr_2$	Weight of $MnBr_2$ in vacuum (grms.).	Corrected weight of residue (grm.).	Change in weight of boat (grm.).	Weight of AgBr in vacuum (grms.).	Loss on fusion (grm.).	Corrected weight of asbestos (grm.).	Weight of AgBr from wash-waters (grm.).	Corrected weight of $MnBr_2$ (grms.).	Corrected wt. of AgBr (grms.).	Atomic weight of manganese.
16.	A_2	5·58461	0·00037	+0·00008	9·76524	0·00032	0·00069		5·58416	9·76561	54·964
17.	A_2	5·63458	0·00022	+0·00004	9·85295	0·00030	0·00073	0·00007	5·63432	9·85345	54·961
18.	A_2	6·53738	0·00000	−0·00004	11·43246	0·00029	0·00078	0·00005	6·53738	11·43300	54·957
19.	A_1	4·81026	0·00019	+0·00002	8·41199	0·00024	0·00031		4·81005	8·41206	54·959
20.	C_1	4·88124	0·00027	0·00000	8·53619	0·00022	0·01039	0·00006	4·88097	8·53642	54·950
21.	C_1	5·63234	0·00022	−0·00007	9·84971	0·00009	0·00046		5·63219	9·85008	54·954
22.	C_1	6·52653	0·00017	+0·00010	11·41232	0·00018	0·00061	0·00018	6·52626	11·41293	54·968
23.	A_1	5·79927	0·00008	−0·00005	10·14153	0·00013	0·00061	0·00005	5·79924	10·14206	54·957
24.	A_1	3·59834	0·00015	+0·00010	6·29262	0·00014	0·00023		3·59809	6·29271	54·952
25.	B_1	5·16345	0·00019	−0·00008	9·02941	0·00005	0·00023	0·00004	5·16334	9·02959	54·966
26.	B_1	3·92230	0·00014	−0·00010	6·85939	0·00012	0·00012	0·00041	3·92226	6·85968	54·951
27.	B_1	4·49181	0·00032	−0·00009	7·85527	0·00015	0·00059		4·49158	7·85571	54·942
28.	C_1	3·60099	0·00016	+0·00012	6·29731	0·00014	0·00023		3·60071	6·29740	54·949
29.	D_1	4·77414	0·00022	0·00000	8·34878	0·00020	0·00057		4·77392	8·34915	54·951
30.	D_1	3·57674	0·00015	−0·00001	6·25541	0·00018	0·00046		3·57660	6·25569	54·933
31.	D_2	5·69991	0·00026	−0·00007	9·96830	0·00020	0·00030		5·69972	9·96840	54·947
								Average, rejecting Analysis 30			54·955
								Average of Series I. and II...			54·957

Series III.—$MnCl_2 : 2Ag$. (Ag = 107·930, Cl = 35·473).

No. of analysis.	Sample of $MnCl_2$	Sample of Ag.	Weight of $MnCl_2$ in vacuum (grms.).	Corrected weight of residue (grm.).	Change in weight of boat (grm.).	Weight of Ag in vacuum (grms.).	Weight of Ag added or subtracted (grm.).	Corrected wt. of $MnCl_2$ (grms.).	Corrected weight of Ag (grms.).	Atomic weight of manganese.
32.	B_2	L	4·62985	0·00017	−0·00002	7·93730	+0·00010	4·62970	7·93740	54·960
33.	B_1	L	3·52899	—	−0·00001	6·05071	−0·00030	3·52899	6·05041	54·958
34.	B_1	L	3·30881	0·00000	−0·00010	5·67299	−0·00020	3·30881	5·67279	54·960
35.	E_1	L	3·56859	0·00014	+0·00002	6·11818	0·00000	3·56843	6·11818	54·955
36.	E_1	K	3·45114	0·00023	+0·00008	5·91647	−0·00010	3·45083	5·91637	54·958
37.	B_1	L	4·47948	0·00008	−0·00015	7·68015	−0·00020	4·47948	7·67995	54·959
38.	E_1	M	3·92089	0·00002	−0·00005	6·72232	−0·00005	3·92089	6·72227	54·958
								Average		54·958

THE ATOMIC WEIGHT OF MANGANESE (*continued*).

Series IV.—$MnCl_2$: 2AgCl.

No. of analysis.	Sample of $MnCl_2$	Weight of $MnCl_2$ in vacuum (grms.).	Corrected weight of residue (grm.).	Change in weight of boat (grm.).	Weight of AgCl in vacuum (grms.).	Loss on fusion (grm.).	Weight of asbestos (grm.).	Weight of AgCl from wash-waters (grm.).	Corrected wt. of $MnCl_2$ (grms.).	Corrected wt. of AgCl (grms.).	Atomic weight manganese.
39.	B_2	4·62985	0·00017	−0·00002	10·54532	0·00006	0·00017	0·00098	4·62970	10·54641	54·957
40.	B_1	3·52899	—	−0·00001	8·03616	0·00013	0·00046	0·00219	3·52899	8·03868	54·962
41.	B_1	3·30881	0·00000	−0·00010	7·53598	0·00014	0·00040	0·00107	3·30881	7·53731	54·959
42.	E_1	3·56859	0·00014	+0·00002	8·12767	0·00005	0·00042	0·00128	3·56843	8·12932	54·950
43.	E_1	3·45114	0·00023	+0·00008	7·85947	0·00012	0·00053	0·00141	3·45083	7·86129	54·952
44.	B_1	4·47948	0·00008	−0·00015	10·20110	0·00007	0·00078	0·00191	4·47948	10·20372	54·963
45.	E_1	3·92089	0·00002	−0·00005	8·92964	0·00004	0·00038	0·00142	3·92089	8·93140	54·962

Average .. .. 54·958

Average of Series III. and IV. .. .. 54·958

cadmium halides (*Am. Chem. Journ.*, 1904, xxxi., 220), with the following results :—

Density of $MnBr_2$.

(Density of Toluene, 25°/4° = 0·86156).

Weight of $MnBr_2$ in vacuum.	Weight of toluene displaced in vacuum.	Density of $MnBr_2$.
Grms.	Grm.	25°/4°.
0·0098	0·5914	4·385
3·0342	0·5963	4·384

Average .. .. .. 4·385

Density of $MnCl_2$.

(Density of Toluene, 25°/4° = 0·86166).

Weight of $MnCl_2$ in vacuum.	Weight of toluene displaced in vacuum.	Density of $MnCl_2$.
Grms.	Grm.	25°/4°.
1·9436	0·5617	2·982
2·8532	0·8266	2·974
3·1202	0·9035	2·976

Average .. .. .. 2·977 (*a*)

(*a*) Shröder obtained the value 2·478. "Dichtigkeits-messungen," Heidelberg, 1873.

All weights were reduced to the vacuum standard by applying the following corrections for each apparent grm. of substance :—

	Specific gravity.	Vacuum correction.
Weights ..	8·3	
$MnBr_2$	4·385	+0·000129
$MnCl_2$	2·977	+0·000259
AgBr	6·473	+0·000041
AgCl	5·56	+0·000071
Ag	10·50	−0·000031
Toluene ..	0·862	+0·00126

The balance was a new Troemner, No. 10, and was easily sensitive to one-fiftieth of a mgrm. with a load of less than 50 grms. The weights, which were of brass, gold-plated, were occasionally carefully standardised to hundredths of a mgrm. The corrections did not vary with time, however. All weighings were made by substitution, with tare vessels as nearly like those being weighed as possible.

The atomic weights involved in the calculations are assumed to be as follows :—Ag = 107·930 ; Br = 79·953 (Baxter, *Proc. Am. Acad.*, 1906, xlii., 201) ; Cl = 35·473 (Richards and Wells, "Publications of the Carnegie Institution," 1905, No. 28).

Series	I. $MnBr_2$: 2Ag	54·959
„	II. $MnBr_2$: 2AgBr ..	54·955
„	III. $MnCl_2$: 2Ag	54·958
„	IV. $MnCl_2$: 2AgCl ..	54·958
	Average	54·958

The close agreement of the averages of the four series is conclusive evidence that no serious error, such as occlusion by the silver halides, affected the method of analysis. This is strikingly shown by the ratio between the silver used and the silver halide obtained in the same analysis.

	Ag : AgBr.
Analyses 1 and 18	57·4438
„ 2 „ 19	57·4459
„ 3 „ 20	57·4426
„ 4 „ 21	57·4425
„ 5 „ 23	57·4439
„ 8 „ 24	57·4439
„ 9 „ 25	57·4457
„ 10 „ 26	57·4432
„ 11 „ 27	57·4423
„ 12 „ 28	57·4421
„ 13 „ 29	57·4454
„ 14 „ 30	57·4387
„ 15 „ 31	57·4456
Average	57·4435
Average, rejecting Analyses 14 and 30	57·4439

The most probable value for this ratio has recently been shown to be 57·4453 (Baxter, *loc cit.*).

Richards and Wells have proved beyond question that the ratio of silver to silver chloride is as low as 75·2634 (*loc. cit.*), a value which is identical with that obtained from the analysis of manganous chloride.

	Ag : AgCl.
Analyses 32 and 39	75·2615
„ 33 „ 40	75·2662
„ 34 „ 41	75·2628
„ 35 „ 42	75·2607
„ 36 „ 43	75·2595
„ 37 „ 44	75·2662
„ 38 „ 45	75·2656
Average	75·2632

It is interesting to tabulate the analyses according to the specimens of material employed.

Average of analyses with Samples A_1 and A_2 of $MnBr_2$	54·959
Average of analyses with Sample B_1 of $MnBr_2$	54·958
Average of analyses with Sample C_1 of $MnBr_2$	54·958
Average of analyses with Samples D_1 and D_2 of $MnBr_2$	54·951 (*a*)
Average of analyses with Samples B_1 and B_2 of $MnCl_2$	54·960
Average of analyses with Sample E_1 of $MnCl_2$	54·956
Average	54·957

(*a*) Analysis 30 is rejected.

Average of analyses with Sample	H	of Ag	..	54·958
,, ,,	J	,,	..	54·961
,, ,,	K	,,	..	54·959
,, ,,	L	,,	..	54·959
,, ,,	M	,,	..	54·958
Average..				54·959

The purification of sample B was exceptionally thorough. In the first place potassium permanganate is isomorphous with a comparatively limited number of substances, so that the initial purification by a large number of crystallisations of this substance may be expected to have eliminated every trace of impurity of heavy metals. In the second place, the final product had been many times re-crystallised in the form of two other compounds of manganese. It is almost inconceivable that any impurity could have eluded this large number of crystallisations in three different forms. That such a prolonged purification was unnecessary is shown by the agreement of the results from the other samples with that from Sample B. Even in the case of Samples A, C, D, and E the final product had been re-crystallised in at least two forms. The slightly lower results in the case of Sample D differ from the others by an amount no greater than the possible experimental error, and can not be considered to indicate that the composition of this sample is different from that of the others.

The various samples of silver also yielded essentially the same result, which confirms the statement as to the identity of the different samples made on page 111.

There can be little doubt that the final average of all four series, 54·96, represents with accuracy the relation of the atomic weight of manganese to that of silver 107·930. This value is in such close agreement with the value derived from previous investigations, that until the relation of oxygen to silver is more accurately known no change in the atomic weight of manganese need be made from the value 55·0, now accepted by the International Committee on Atomic Weights.

The main results of this research may be briefly summarised as follows:—

1. The atomic weight of manganese, referred to silver 107·930, is found to be 54·96, by analysis of both manganous bromide and manganous chloride.

2. The specific gravity of manganous bromide at 25°, referred to water at 4°, is found to be 4·385, and that of manganous chloride under the same conditions is found to be 2·977.

We are deeply indebted to the Carnegie Institution of Washington for funds which have made this investigation possible, and also to Dr. Wolcott Gibbs and the Cyrus M. Warren Fund for Research in Harvard University for many indispensable platinum vessels.

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 114).

Procedures and Notes (continued).

Procedure 3.—If organic matter is absent (P. 1), reduce the substance to a finely divided form (as described in N. 1); weigh out into a casserole about 1 grm. if it is a non-metallic substance, or about 0·5 grm. if it is an alloy.

In case the substance is not an alloy, add to it 10 to 30 cc. water, heat to boiling, and test the solution with litmus-paper. If the substance has dissolved completely and the solution is neutral or acid, treat the solution by P. 11. If there is a residue or if the solution is alkaline, add carefully without filtering 5 to 10 cc. HNO_3 (1·42), and evaporate just to dryness.

In case the substance is an alloy, pour over it 10 cc. HNO_3 (1·20), cover the dish with a watch-glass, heat the mixture on a steam-bath as long as any action continues, adding a little HNO_3 (1·42) if action is renewed thereby, or a little water if crystalline salts have separated, and then evaporate just to dryness.

Heat the residue obtained in either case at 120—130° until it is perfectly dry, by keeping the casserole in motion over a flame, or, better, by heating it in a hot closet at that temperature for at least half-an-hour. Loosen the dehydrated residue from the dish, and rub it to a fine powder with a pestle; add to it 5 to 10 cc. HNO_3 (1·20), cover the dish, and heat on a steam-bath for ten minutes. Dilute with 20 cc. water, heat to boiling, filter, and wash the residue. (Residue, P. 4). To the solution add 5 cc. HCl (1·20) to precipitate the silver group, filter, and wash the precipitate with a little cold water, adding the washings to the filtrate. (Precipitate, P. 12; filtrate, P. 4, second paragraph).

Notes.

1. In order that in the following procedures difficultly soluble substances may be dissolved, the substance must be reduced to a very fine powder. This is usually best accomplished by grinding the substance, in small quantities at a time, in a mortar. With hard substances, and in general with minerals, an agate mortar should be used. Most alloys cannot be powdered in this way; these may be converted into a form that offers a large surface by hammering in a steel mortar, filing with a fine steel file, shaving with a knife, or converting into turnings with a lathe.

2. The quantity of the substance taken for analysis should always be approximately known; for a good qualitative analysis should show, not merely the presence or absence of the various elements in the substance, but should enable their relative quantities to be estimated. Since 1 to 2 mgrms. of almost any element can be detected by this system of analysis, the presence of 0·1 to 0·2 per cent of an element will be detected when a grm. of substance is taken, and this degree of delicacy is ordinarily sufficient. If much more than this quantity is taken, the precipitates may be so large that much time is consumed in filtering and washing them. For this reason it is best to use only about half a grm. of an alloy, since, owing to the absence of acid radicals, the same quantity of metallic elements is contained in a less amount of substance.

3. When the substance dissolves only partly in water, it is not worth while to filter off the residue and analyse it and the solution separately, unless special information in regard to the soluble constituents is desired. If therefore it is known to be partly insoluble in water, it is best treated at once with HNO_3, as is directed in the case of an alloy. If, however, it is completely soluble in water, the addition of HNO_3 is avoided, since it would have to be removed before the subsequent precipitation with H_2S.

4. If the aqueous solution has an alkaline reaction, the addition of an acid may cause precipitation of any substance held in solution by an alkaline solvent; for example, sulphur or sulphides of the tin group from an alkaline sulphide solution; silver chloride or cyanide from a potassium cyanide solution; silicic acid from sodium silicate solution; or metallic hydroxides from solutions in alkalis. An alkaline solution should therefore not be treated directly with HCl by P. 11, for the precipitate formed might contain other substances than chlorides of the silver group.

5. An acid reaction of the aqueous solution is due to hydrogen ions, which may arise from free acid, from an acid salt of a strong acid, or (by hydrolysis) from a neutral salt of a strong acid and a weak base. An alkaline reaction is due to hydroxide ions, which may arise from a soluble hydroxide, or (by hydrolysis) from a carbonate, sulphide, phosphate, borate, cyanide, or a salt of some other weak acid. It is to be noted that the

* From the *Technology Quarterly*, xix., No. 3, September, 1906.

terms "acid salt" and "neutral salt" refer only to the extent of the replacement of the hydrogen of the acid by the metallic element, and do not show the reaction towards litmus or other indicators. This reaction depends on the presence of a sufficient concentration of hydrogen or hydroxide ions to affect the indicator employed. Thus the neutral salts Na_2CO_3, Na_2S, &c., and even the acid salts $NaHCO_3$, Na_2HPO_4, react alkaline with litmus; while some other neutral salts, such as $Al(NO_3)_3$, react acid.

6. When an acid is added to a non-metallic substance or its aqueous solution, the evolution of any gas and its odour should be noted, since this indicates the nature of the acid radical present. Thus carbonates evolve CO_2; sulphides, H_2S; sulphites, SO_2; and cyanides, HCN. On boiling the HNO_3 solution, the presence of sulphides is further indicated by the separation of sulphur as a spongy or pasty mass, which floats on the surface, and may be removed by means of a spatula or rod, and the presence of iodides is shown by the liberation of free iodine, which may separate as a black precipitate, which imparts a brown colour to the solution, and which gives rise to violet vapours above it.

7. In dissolving non-metallic substances either HNO_3 or HCl may be first used, each having advantages and disadvantages of its own. HNO_3 dissolves owing to its oxidising power, many alloys and sulphides not attacked by HCl, but fails to dissolve certain oxides, especially MnO_2, Sb_2O_5, and hydrated SnO_2, which dissolve in HCl. HCl may cause the precipitation of chlorides of the silver group; while strong HNO_3 on heating oxidises sulphides partially to sulphates, and may cause the precipitation of lead, barium, strontium, and calcium sulphates; thus in either case making it sometimes impossible to determine whether complete decomposition has resulted. HNO_3 oxidises mercurous, arsenous, antimonous, stannous, and ferrous compounds to the higher state of oxidation; consequently, almost all the antimony and tin will usually be found in the residue insoluble in dilute HNO_3 after evaporation, all the mercury will be in the H_2S precipitate, and sulphur will always be precipitated by H_2S when iron is present. When HCl is used as a solvent, mercury, selenium, and arsenic in the arsenous form would be wholly or partly lost, owing to the volatility of their chlorides, in the subsequent evaporation, which is necessary in order to remove silica. For this last reason, and for the reason that the procedure is a more general one in that it provides for the solution of alloys and of a larger proportion of non-metallic substances and for the isolation of the silver group, the use of HNO_3 is here recommended. In special cases it is advantageous to use dilute HCl instead of HNO_3, especially when the substance dissolves completely in HCl, and it is not necessary to evaporate the solution to remove silica.

8. When a silicate is decomposed by acid, silicic acid may separate as a gelatinous precipitate, but even then a part of it always remains in solution, mainly as a colloid. When thoroughly dried at 100—130°, it is partially dehydrated, and becomes entirely insoluble. The HNO_3 acid solution is therefore evaporated to dryness, and the residue is heated at 120—130°, in order to remove the silica at this point; for, if it were not removed, it would appear as a gelatinous precipitate at some later stage of the analysis; thus, if it did not separate earlier, it would be precipitated by NH_4OH together with the iron group, and might then be mistaken for aluminium hydroxide. In the case of non-metallic substances which cannot contain silica, the evaporation and heating at 120—130° may be omitted.

9. With reference to the treatment of alloys with HNO_3 the following facts should be borne in mind. All the more common elements are dissolved by strong HNO_3 except antimony, tin, and silicon. These are oxidised to antimonic acid ($Sb_2O_5.nH_2O$), metastannic acid (nH_2SnO_3), and silicic acid, which separate at once as white amorphous precipitates except when only small amounts of these elements are present. Certain nitrates, especially that of lead, may separate in crystalline form from the strong HNO_3, but these dissolve upon adding water and heating to boiling. *Of the more important rarer elements, titanium and tungsten, like antimony and tin, separate in the form of insoluble hydroxides; in the case of tungsten, tungstic acid (H_2WO_4) separates as a dense precipitate of a yellow colour.

10. In the case of an alloy the evaporation to dryness and heating at 120—130° serve to partially dehydrate the hydroxides of silicon, tin, antimony, titanium, and tungsten, whereby they are rendered nearly insoluble in HNO_3, and thus make possible a conclusion in regard to their presence or absence. If after having thoroughly dried the mixture at this temperature there is no residue insoluble in the HNO_3 (1·20), it shows the absence of silicon, tin, and tungsten in quantity as large as 1 mgrm., and that of antimony and titanium in quantity as large as 2 or 3 mgrms. The fact must not be overlooked, however, that in the dehydrated form even a very small residue or slight turbidity may correspond to an appreciable quantity of one of these elements. Therefore, if no residue can be seen, rub the sides of the dish gently with the rubber-covered end of a glass rod, pour into a small flask, allow the liquid to stand two or three minutes, and note whether there is any residue whatever. The knowledge that tin is absent is helpful, since the subsequent procedures for the detection of this element may be omitted. The subsequent procedures for antimony may, in the absence of a residue, also be omitted, provided quantities as small as 3 mgrms. are not to be tested for. In addition to the hydroxides named above the residue may also contain a considerable quantity of stannic phosphate or arsenate when tin and phosphorus or arsenic are simultaneously present, or of bismuth hydroxide when both antimony and bismuth are present; also small quantities of various other elements enclosed in a residue consisting of those already mentioned.

11. The hydroxides referred to in the last two notes usually separate also in the treatment of non-metallic substances with HNO_3 when the corresponding elements are present; but the non-existence of a residue must not, except in the case of silicon, be regarded as conclusive evidence of their absence in such substances. For acid radicals may be present which by combination with the hydroxides cause them to remain in solution; thus the presence of chloride or sulphate might cause a considerable quantity of tin, antimony, or titanium to dissolve, while that of phosphate might lead to the solution of even a large quantity of tungsten.

12. A black or metallic residue insoluble in HNO_3, obtained in the case of an alloy, may contain carbon or carbides, certain alloys of iron, such as ferrochrome or ferrosilicon, gold, or any of the platinum metals. If there is no such residue, it shows the absence of gold and platinum.

13. If the substance is non-metallic, the residue insoluble in HNO_3 probably consists of one or more of the following substances:—The partially dehydrated hydroxides of tin, antimony, silicon, titanium, and tungsten; the native or ignited oxides of the same elements, of aluminium, and of chromium; anhydrous chromic salts; the peroxides of manganese and lead; the sulphates of barium, strontium, and lead; the sulphides of mercury and molybdenum; silica; the silicates and fluosilicates of many elements; fluoride of calcium; the halides of silver and lead; the phosphates of tin and of rare earths; ferrocyanide of iron; sulphur; carbon; silicon carbide.

14. In regard to the precipitation of the silver group by HCl, see notes on P. 11.

Procedure 4.—To the residue insoluble in HNO_3 (P. 3) in a casserole add gradually 5 to 10 cc. HCl (1·20), and heat as long as action continues, adding more acid if necessary. If the substance does not dissolve completely in HCl, add to the mixture without filtering one-third its volume of HNO_3 (1·42), and heat gently as long as action continues, adding more of the acids if necessary.

To this solution in HCl alone, or in HCl and HNO_3, without filtering off any residue, add the filtrate obtained in P. 3, and evaporate the mixture nearly to dryness. In order to expel the HNO_3, moisten the residue with 2 to 5 cc. HCl (1·20), and evaporate to dryness. Thoroughly dry the residue by heating it at 120—130° in a hot closet or by keeping it in motion over a small flame. Add to the residue 4 cc. HCl (1·12), measured in a small graduate, and about 20 cc. water; boil gently for a few minutes if there is a residue; filter, and wash the residue thoroughly with boiling water. Pour the filtrate into a graduate, and add enough water to make its volume 40 cc. (Residue, if non-metallic, P. 5, if metallic, P. 4, N. 2; solution, P. 21).

Notes.

1. Of the substances that may be present in the residue undissolved by HNO_3 (see P. 3, N. 12 and 13) the peroxides of manganese and lead are reduced and dissolved by concentrated HCl; antimonic acid, stannic phosphate, and much metastannic acid are also dissolved by it. Upon the addition of HNO_3, whereby the strongly oxidising mixture known as aqua regia is produced, gold, platinum, and mercuric sulphide are entirely dissolved; and silver compounds, such as AgBr, AgI, and AgCN, are converted into AgCl. The chloride of silver and the sulphates of strontium and lead dissolve in large quantity in the concentrated acids, but only in much smaller quantity in the small amount of dilute HCl added after the evaporation. Some of the other substances that may be in the residue, especially the oxides and certain silicates, are slowly attacked by the strong acids, but the solvent action is not rapid enough to make this a practicable method.

2. If the original substance was an alloy, a residue after the treatment with HCl and HNO_3 probably consists, if non-metallic, only of metastannic, silicic, titanic, or tungstic acid; if black or metallic, of carbon, a platinum metal, or an alloy of iron with chromium, silicon, &c. If non-metallic, it is treated with H_2SO_4 and HF by the regular procedure, in order to test for and remove silica and to dissolve metastannic and titanic acids. If metallic, such a treatment would not effect solution; the residue is then best fused with Na_2O_2 in a nickel crucible, the mass treated with water and HCl, and the solution analysed as usual, except that nickel cannot be tested for. (For a description of this process and the results attained by it, see A. A. Noyes, "System of Qualitative Analysis including nearly all the Metallic Elements," Part I., Procedure 13, published in the *Technology Quarterly*, 1903, xvi., p. 113; see also CHEMICAL NEWS, xciii., p. 134 *et seq.*).

3. The solution is evaporated to render insoluble silicic acid which may have come from the decomposition of silicates, and to remove the large quantity of acid which would otherwise interfere with the H_2S precipitation. The evaporation with HCl serves, moreover, to remove HNO_3, which, if present in large quantity, would destroy the H_2S with liberation of sulphur. Since the success of the separation by H_2S of the copper and tin groups from the iron group requires a proper concentration of acid in the solution, a measured quantity of HCl is added, and the solution is diluted to a definite volume.

4. If the original substance was an alloy and a large non-metallic residue remains after treatment with HNO_3 (P. 3), it is sometimes advantageous to analyse the residue separately by the following procedure, by which a large quantity of metastannic acid is more readily dissolved:—Add to the residue in a casserole 3 to 4 cc. concentrated H_2SO_4, and heat under the hood until the acid has evaporated to a volume of about 2 cc. Cool, add an equal volume of water, cool again, add 5 cc. HCl (1·12) to dissolve antimonic oxide, and heat to boiling. Cool completely, filter if there is a residue (which may consist of silicic or tungstic acid), and add the acid solution drop by drop, with constant shaking, to a mixture of 10 cc. ammonium monosulphide, 1 cc. ammonium polysulphide, and 10 cc. NH_4OH (0·90) in a flask. Cover the flask, and digest for a few minutes on a steam-bath. Filter out the precipitate, which may consist of titanium hydroxide or small quantities of sulphides of the copper and iron groups. Dilute the filtrate, and make it slightly acid with HCl. Shake to coagulate the precipitate, filter, and wash with hot water. Analyse the precipitate for the tin group by P. 42; reject the filtrate or test it for phosphate with molybdic acid.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, February 21st, 1907.

Prof. R. MELDOLA, F.R.S., President, in the Chair.

(Concluded from p. 117).

42. "*The Reduction Products of* o- *and* p-*Dimethoxybenzoin.*" By JAMES COLQUHOUN IRVINE and AGNES MARION MOODIE.

o-Dimethoxybenzoin has been converted into the corresponding hydrobenzoin, and the latter compound, when reduced by Baeyer's process, gives *p*-dimethyltolane. This abnormal change has been shown to take place through the intermediate formation of *o*-dimethoxydiphenylethylene together with the corresponding ethane derivative.

As this result indicates that Baeyer's method of reduction may lead to erroneous conclusions in deducing the constitution of aromatic alkyloxy-compounds, a detailed study of the effect of the process on derivatives of anisoin has been made. It has been shown that both anisoin and its methyl ether are converted into deoxyanisoin when distilled with zinc-dust in a current of carbon dioxide, and that the reduction is only complete when carried out in an atmosphere of hydrogen. The hydrocarbon finally obtained was stilbene.

In the course of the work a number of new derivatives of anisoin were prepared and examined.

43. "*Constituents of Natural Indigo.*" (Part II.). By ARTHUR GEORGE PERKIN.

Preliminary accounts of a portion of this work have previously appeared (*Proc.*, 1904, xx., 172; 1906, xxii., 199). The kaempferol glucoside, kaempferitrin, contained in the *Indigofera arrecta* is not hydrolysed by the insoluble indigo enzyme of Beyerinck (*Proc. K. Akad. Wetensch. Amsterdam*, 1900, 120), and its appearance in Java indigo is probably due to some extent to the employment of sulphuric acid at one stage of the manufacture. Numerous Java indigos have been examined, and all contained kaempferol, but in no case did this exceed 0·2 per cent. The leaves of the *Indigofera sumatrana* contain a trace of yellow colouring matter which probably consists of kaempferol.

44. "*The Velocity of Hydrolysis of Aliphatic Amides.*" By JAMES CODRINGTON CROCKER.

The rates of reaction of formamide, acetamide, propionamide, butyramide, *iso*butyramide, valeramide, capronamide with hydrochloric acid have been determined at from 40° to 80°. The determinations were carried out by measurement of the specific conductivity of the reacting mixture. Owing to the effect of the dissolved amide on

the conductivity of the solution, the concentration could not be calculated directly from the specific conductivity. Synthetical mixtures were prepared representing definite stages of the reaction, and the variation of the specific conductivity of these with time was determined. By extrapolation to $t = 0$ the initial specific conductivity was determined in each case. A concentration-conductivity curve was plotted which served to standardise the original conductivity-time curve. The reactions are bimolecular, and follow the relation $K = \frac{1}{\alpha t}\left(\frac{1}{C} - \frac{1}{C_0}\right)$, where α is the degree of dissociation of the hydrochloric acid. The order of the relative reactivities is the same for each temperature; this order is formamide, propionamide, acetamide, *iso*butyramide, capronamide, butyramide, valeramide. The temperature coefficients of reactivity are very large, and the velocity constants closely follow the temperature law, $\log K = \log K_0 + B\left(\frac{1}{T} - \frac{1}{T}\right)$.

A relation between the reactivity of the amides at constant temperature and the strength of the corresponding organic acids was indicated. The relative reactivities of the amides were also evaluated at "corresponding" temperatures, and these values were shown to be nearly independent of temperature.

45. "*The Rusting of Iron.*" By Wyndham Rowland Dunstan.

As a result of a long series of experiments (Dunstan, Jowett, and Goulding, *Trans.*, 1905, lxxxvii., 1548), it was shown that the rusting of iron can take place in the absence of carbonic acid, and that only iron, oxygen and liquid water are necessary for rusting to occur. In order to elucidate the chemical change involved, and to explain the inhibiting effect on the rusting of iron produced by some substances and especially by alkalis and potassium dichromate, the working hypothesis was suggested that the formation of hydrogen peroxide is concerned in the change, rusting being prevented by those substances which are capable of decomposing the peroxide.

Recently, Dr. Gerald T. Moody (*Trans.*, 1906, lxxxix., 720) has published an account of experiments he has made which in his opinion prove that iron cannot rust in the absence of carbon dioxide. In the experiments recorded by the present author (*loc. cit.*) elaborate precautions were taken to ensure the absence of carbon dioxide, but it has been thought desirable to repeat the experiments made under somewhat different conditions by Dr. Moody. His conclusions have not, however, been confirmed; the results of experiments carried out in the manner described by him show that iron rusts freely in the absence of carbonic acid provided that iron, oxygen, and liquid water are brought together.

46. "*Contributions to the Chemistry of the Rare Earths.*" (Part II.) By Mario Esposito.

The methods of Muthmann and Böhm and Pattinson and Clarke for the preparation of ceria have been found to give a fairly pure product. Oxidation with potassium permanganate, according to Drossbach and Böhm's method, is probably the most rapid and satisfactory way of obtaining almost pure ceria.

Lanthana and old didymia can be separated by fractional crystallisation of the oxalates from strong nitric acid, but the process is not advantageous. Lanthana is best obtained by a modification of the method of Auer von Welsbach (fractional crystallisation of the double ammonium nitrates), which at the same time effects the separation of neodymia and praseodymia, the chief constituents of old didymia. After one hundred and ten fractionations, lanthana, praseodymia, and neodymia were obtained in a state of considerable purity.

47. "*Derivatives of Multivalent Iodine.* Part III. *Action of Heat on Iodobenzene Dichloride, and on the* m- *and* p-*Nitro- and* p-*Chloro-derivatives.*" By William Calswell and Emil Alphonse Werner.

The authors have found that when iodobenzene dichloride is heated it undergoes sudden decomposition at 112—136° according to the rate of heating, the main change resulting in the formation of *p*-chloroiodobenzene. Only from 17 to 27 per cent of the theoretical amount of chlorine is evolved in the free state. Rapid heating favours the formation of the substitution derivative. Whilst *o*- and *p*-iodonitrobenzene dichloride, when heated, decompose quantitatively in accordance with the equation $C_6H_4(NO_2)\cdot ICl_2 = C_6H_4(NO_2)I + Cl_2$, the *m*-derivative loses from 72—73 per cent of its chlorine in the free state, a substitution derivative being produced in corresponding proportion.

p-Chloroiodobenzene forms a dichloride, $C_6H_4Cl\cdot ICl_2$, which decomposes at 112°, the proportion of chlorine evolved in the free state amounting to 72 per cent of the theoretical for the loss of two atoms. Thus the nitro-group in the ortho- and para-positions completely prevents the formation of substitution products, whilst chlorine in the para- has the same inhibiting effect as the nitro-group in the meta-position.

48. "*The Organic Phosphorus Compound formed by Yeast-juice from Soluble Phosphates.*" (Preliminary Notice). By William John Young.

It has been shown by Harden and Young (*Proc.*, 1905, xxi., 189; *Proc. Roy. Soc.*, 1906, B, lxxvii., 405) that when soluble phosphates are added to a fermenting mixture of yeast-juice and glucose a large increase in the rate of evolution of carbon dioxide is observed. This rate soon diminishes until a constant rate is attained, which is usually approximately equal to that of the original yeast-juice and glucose. It has been further shown that at the end of this period of increased fermentation, the phosphate has undergone some alteration, and is no longer present in the form precipitable by magnesium citrate mixture, and it was suggested that a combination with the glucose to form a phosphoric acid ester had taken place.

Experiments on the chemical nature of this compound have been carried out, and although not yet complete, it has been thought advisable to communicate a preliminary notice of the results so far obtained, in view of the publication of Iwanoff (*Zeit. Physiol. Chem.*, 1907, l., 281), who appears to have obtained the same substance independently.

A lead salt of the compound was prepared from the fermentation mixture by first removing any free phosphate by magnesium nitrate and then adding lead nitrate. Analyses of two preparations, in which the carbon, hydrogen, lead, and phosphorus were determined, gave the empirical formula $C_3H_5O_6PPb$.

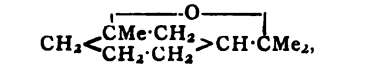
On suspending this salt in water and removing the lead with hydrogen sulphide, an acid solution is obtained which reduces Fehling's solution and gives Mohlisch's α-naphthol reaction. It is slightly dextrorotatory, and can be titrated with alkalis, using phenolphthalein as indicator, in a similar manner to phosphoric acid. On evaporating to dryness on the water-bath a charred mass is left, which contains free phosphoric acid, and has a strong odour of caramel, whilst on evaporation at the ordinary temperature in a vacuum over sulphuric acid a syrupy mass is left, which soon darkens in colour and decomposes.

When the solution is boiled for several hours the compound is slowly hydrolysed, phosphoric acid being set free, and a substance formed which reduces Fehling's solution more strongly than the acid itself, and rotates the plane of polarised light to the left. The nature of this reducing substance has not been exactly determined, and experiments with this object are in progress.

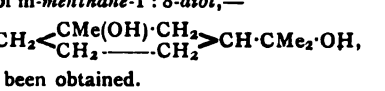
49. "*Experiments on the Synthesis of the Terpenes.* Part X. *Synthesis of Carvestrene and its Derivatives.*" By William Henry Perkin, jun., and George Tattersall.

Continuing their work on the synthesis of carvestrene

(*Proc.*, 1906, xxii., 268), the authors have prepared m-*cineol*,—



by the action of magnesium methyl iodide on ethyl *cyclo*-hexanone-3-carboxylic acid, and the *cis*- and *trans*-modifications of m-*menthane*-1 : 8-*diol*,—



have also been obtained.

INSTITUTE OF CHEMISTRY.

Annual General Meeting, March 1st, 1907.

Prof. Percy F. Frankland, LL.D., F.R.S., President, in the Chair.

The financial statements for the year 1906 having been duly received, on the motion of Mr. A. Gordon Salamon, Hon. Treasurer, seconded by Mr. Thomas Tyrer, Professor J. Millar Thomson moved the adoption of the annual report of the Council, at the same time commenting on the recent work of the Institute. The Fellows now number 1016, and there are 177 Associates. The work of the Council and Committees during the year necessitated no less than 64 meetings, and the report contained several interesting items, such as the establishment of examinations in Chemical Technology, the further extension of the work of the Institute in the Colonies, the action taken by the Council in various matters affecting the interests of professional chemists, and the suggestion that the Intermediate and Final Examinations should be conducted by a board of Examiners, which appeared to him a step in the right direction.

Dr. W. A. Tilden, in seconding the adoption of the report, cordially congratulated the Council on the progress made by the Institute in the past few years, but he remarked that the new developments, such as the Examinations in Chemical Technology and holding Examinations in the Colonies, were serious steps requiring very careful managemeat.

The Report was then formally received and adopted.

The ballot for the election of Censors having been taken, the following were declared elected:—Professor Edward Divers, D.Sc., F.R.S.; Mr. David Howard; Sir William Ramsay, and Professor J. Millar Thomson, LL.D., F.R.S. The meeting proceeded to appoint the Honorary Auditors:—Messrs. W. T. Burgess and P. A. E. Richards being re-appointed, and Mr. Walter F. Reid being elected to the vacancy caused by the retirement of Mr. R. E. Alison.

The President then delivered his Address. After thanking the Fellows and Associates for electing him to the office of President, he said he valued the distinction not only for the confidence and good will of his colleagues which it implied, but also because it placed him in the Chair once occupied by his father, the late Sir Edward Frankland, K.C.B., F.R.S., the first President of the Institute. There was possibly an unconscious symbolism in his election, for it appeared to mark in the history of the Institute the passage from the first to the second generation; and while his predecessors in the Chair were all founders of the Institute, he had had to gain admission by examination. He remarked that the office of President had been no sinecure, but he had had the good fortune to succeed a President (Mr. David Howard) who justly enjoys a reputation as a man of affairs, and not only did he take over a carefully organised and going concern, but he had the benefit of his predecessor's valuable advice, for which he expressed his best thanks. He also acknowledged the services of the Chairmen of the various Committees. He then referred to the deaths of four distinguished Fellows:—Frederick Claudet, well known as an Assayer; Cornelius O'Sullivan, F.R.S., head of the brewing and scientific staff of Messrs. Bass and Co., of Burton-on-Trent; Charles Tookey, also an Assayer and Metallurgical Expert; and Dr. W. J. Sykes, the Editor of *The Analyst*. The most important feature of the year's work has been the inauguration of examinations in Chemical Technology. The first examination was held in October last, and was so successful that it dissipated any doubts which some may have entertained as to the value of these examinations. The Council believe that the institution of such examinations will materially help Fellows and Associates to obtain employment in chemical industries. Thanks were due to Dr. Ludwig Mond, F.R.S., the Chairman of the Chemical Technology Examinations Board, for valuable advice in connection with the scheme, and to Mr. Oscar Guttmann who had presented the Board with a collection of diagrams of plant and machinery which had been of great service in the oral examinations.

After referring to a number of changes made in the Regulations for admission to the Institute, particularly the deletion of Latin from the list of compulsory subjects in the Preliminary Examination, the President announced the appointment of a new Board of Examiners for the conduct of the Associateship examinations. The Board will be constituted as follows:—For the Intermediate Examination, Mr. Bertram Blount and Dr. G. G. Henderson; for the Final Examinations, Mineral Chemistry, Mr. Bertram Blount; Metallurgical Chemistry, Mr. F. W. Harbord; Physical Chemistry, Dr. T. Slater Price; Organic Chemistry, Dr. G. G. Henderson; the Analysis of Food and Drugs and of Water, Mr. Cecil Cribb; Biological Chemistry, Dr. A. Harden; Therapeutics, Pharmacology, and Microscopy, Dr. F. Gowland Hopkins, F.R.S. The President was sure that the Board thus constituted would make for efficiency, and that it would be difficult to find anywhere more powerful machinery for conducting chemical examinations.

He then referred to the growth of the Library of the Institute, which is mainly supported by the contributions of the Fellows. The Library is essentially a working library, as distinguished from the exhaustive libraries, such as that of the Chemical Society, which the Institute did not wish to attempt to duplicate. Yet another piece of work accomplished was the publication of a List of Official Chemical Appointments, which the President considered one of the most useful publications that had ever emanated from the office of the Institute.

An important function of the Institute is to safeguard the interests of professional chemists. During the past year, the Council had devoted much time to work of this kind, particularly in connection with the appointments of analysts under the Fertilisers and Feeding Stuffs Acts, and the Sale of Food and Drugs Acts. Special thanks are due to Sir William Ramsay, K.C.B., the Chairman of the Public Appointments Committee, which had charge of these matters. If all young chemists were aware of the amount of time and trouble spent by the Council in endeavouring to secure better conditions for professional chemists of every kind, many more would take the examinations and support the Institute in its work.

The President concluded his Address by commenting on the special value of the qualifications of the Associateship and Fellowship of the Institute, and he showed how the examinations of the Institute differed from those of the universities, The latter are contrived to test the amount of knowledge which a candidate has succeeded in bringing to a focus at a particular moment of time, whilst the main object of the examinations of the Institute is to test what the candidate can actually perform when he is placed as nearly as possible under the same conditions as he would be if working in his own laboratory and within reach of a good chemical library. The candidate who shines in the one will not necessarily shine in the other. It is a common

experience for teachers to meet with students of excellent mental ability who readily acquire knowledge of theoretical chemistry even in its more advanced and modern branches, and who talk glibly about the phase rule, the ionic theory, and even the electronic theory of matter, and perhaps can cite correctly author and year for the disovery of reactions in obscure chapters of organic chemistry; yet when it comes to the production of experimental results with their own hands, are hopelessly outclassed by students of more modest theoretical attainments; and whilst the latter meet with remarkable success in their practical work, everything fails in the hands of those who move with such facility in the theoretical part of the subject. The paper man takes, in all probability, an Honours Degree, but should he present himself at the Institute he may ignominiously come to grief because he does not possess even the rudiments of that instinct which is still necessary to the performance of practical chemical work, in spite of the application of higher mathematics to the interpretation of chemical phenomena. Before all things, the Institute's qualification is of a practical nature. The University graduate is more qualified to talk and to teach, but the overcrowding of his curriculum leaves him little time in which to practise and acquire technical skill, without which the Institute's qualification cannot be attained at all. It is this practical character which must be preserved in the Institute's examinations, so that the Fellows and Associates may be known for the soundness of their judgment and for their capacity to perform chemical work upon which the public can place implicit reliance. The Institute must be ever ready to extend the scope of its examinations as new branches of chemistry arise, and in each branch must secure the highest standard of excellence.

On the motion of Mr. R. J. Friswell, seconded by Dr. Edward Divers, F.R.S., a hearty vote of thanks was accorded to the President for his Address.

The Officers and Members of Council for the ensuing year were duly elected as follows:—

President—Percy Faraday Frankland, LL.D., Ph.D., F.R.S.

Vice-Presidents—Edward John Bevan; Edward Divers, M.D., D.Sc., F.R.S.; Oscar Guttmann, M.Inst.C.E.; David Howard; Herbert Jackson; Sir William Ramsay, K.C.B., LL.D., F.R.S.

Hon. Treasurer—Alfred Gordon Salamon, A.R.S.M.

Members of Council—Adrian John Brown, M.Sc.; Russell Forbes Carpenter; Charles Edward Cassal, Col.; John Clark, Ph.D.; Arthur Crozier Claudet, A.R.S.M.; John Norman Collie, Ph.D., F.R.S.; Cecil Howard Cribb, B.Sc.; Bernard Dyer, D.Sc.; Henry John Horstman Fenton, M.A., Sc.D., F.R.S.; Walter William Fisher, M.A.; Martin Onslow Forster, D.Sc., Ph.D., F.R.S.; William Gowland, A.R.S.M.; Henry George Greenish; Egbert Grant Hooper; Arthur Robert Ling; William Macnab; Gerald Tattersall Moody, D.Sc.; Henry de Mosenthal; Henry Droop Richmond; Alfred Smetham; Arthur Smithells, B.Sc., F.R.S.; John Edward Stead, F.R.S.; Francis Napier Sutton; Oliver Trigger; John Augustus Voelcker, M.A., Ph.D., B.Sc.; Alexander Forbes Watson, B.Sc.; William Palmer Wynne, D.Sc.; F.R.S.

With a cordial vote of thanks to the retiring Officers and Members of Council for their services, moved by Mr. Walter Reid and seconded by Mr. R. Forbes Carpenter, to which Mr. Friswell responded, the meeting terminated.

Appointments.—The vacant posts in the Metallurgical Department of the National Physical Laboratory have been filled by the appointment of Mr. J. Murdoch as Senior Assistant, and Mr. S. L. Archbutt as Junior Assistant.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 8, February 25, 1907.

The Lactyllactate of Ethyl.—M. Godchot and E. Jungfleisch.—In their researches upon the lactic acids, the authors found that the facts observed could not be accounted for by any usually defined reactions in connection with complex ethers; but it was found further that they admitted of interpretation upon considerations of a general order. The case here described, a relatively simple one, is that of the products furnished by the action of heat upon ethyl $(d + l)$ lactate. The heating is carried out in sealed tubes at 250° for seven or eight hours, followed by distillation *in vacuo*. The products obtained are as follows:—(1) Ethyl alcohol; (2) towards 65—70°, ethyl lactate; (3) between 110—120°, a colourless syrupy liquid, being the bulk of the remainder; (4) towards 140—150°, a faintly yellow liquid. The third product boils at 215—220° at normal pressure; it has an ethereal odour, and is a colourless liquid of density 1·096 at 0°. It shows the composition of ethyl lactyllactate:— $CH_3—CH(OH)—CO_2—CH(CH_3)—CO_2—C_2H_5$. It has a molecular weight of 199 by the cryoscopic method, the theoretical figure being 192. In its properties the body resembles the monoethyl dilactate described by Wurtz and Friedl in 1861, and obtained by the action of potassium lactate on chloropropionic ether; but the ethyl lactate mixes rapidly with cold water and is saponified by it, while ethyl lactyllactate remains in contact with cold water without being sensibly dissolved by it, and in warm water it disappears slowly with formation of lactic acid. The production of ethyl alcohol with the lactyl-lactate by the action of heat upon ethyl lactate gives the key to the solution of the reaction, the ethyl alcohol of one molecule of ethyl lactate being displaced by the lactic alcohol of another molecule:— $CH_3-CH(OH)-CO_2-C_2H_5 + OH—CH(CH_3)—CO_2-C_2H_5 = CH_3—CH(OH)—CO_2—CH(CH_3)—CO_2—C_2H_5 + C_2H_5—OH$. It is worthy of notice that ethyl lactyllactate is relatively more stable than lactyllactic acid. The fourth product of distillation, obtained between 140° and 150°, boils at 250—260° at normal pressure; it is a syrupy liquid, furnishing crystals when cooled, and these have the same melting-point and properties as the $(d+l)$-dilactide. Its formation may be represented thus:—

$$CH_3—CH(OH)—CO_2 \quad = \quad C_2H_5—CO_2—CH—CH_3$$

$$CH_3—CH—CO_2 \quad = \quad CO_2—CH—CH_3 \quad + OH—C_2H_5.$$

Hence, the products of this reaction with ethyl lactate are found to be analogous to those obtained by heating lactic acid, but the mechanism of the transformations is different. These facts are of a general nature, and apply to similar reactions with ethers of other complex acids.

MISCELLANEOUS.

Royal Institution.—The following are the Lecture arrangements at the Royal Institution after Easter:—Professor G. H. Bryan, two lectures on "Wings and Aeroplanes"; Professor W. Stirling, three lectures on "Stimulation, Luminous and Chemical"; D. S. MacColl, Esq., two lectures on "Alfred Stevens (the English Sculptor and Painter)"; Professor G. H. F. Nuttall, two lectures on "Malaria, Sleeping Sickness, Tick Fever, and Allied Diseases"; Professor H. A. Miers, two lectures on "The Birth and Affinities of Crystals"; Dr. A. W. Werrell, two lectures on (1) "Euripides and his Age, (2) The Bacchants of Euripides"; H. F. Newall, Esq., two lectures on "Spectroscopic

Phenomena in Stars, (1) Chemistry, (2) Motion"; Professor Sir James Dewar, three lectures on "Chemical Progress—Work of Mendeleeff and Moissan"; Professor S. P. Thompson, three lectures on "Studies in Magnetism (the Tyndall Lectures)"; Professor W. C. McIntosh, two lectures on "Scientific Work in the Sea Fisheries"; Arthur Bourchier, Esq., two lectures on "The Limits of the Dramatic Art"; and Sir William H. White, two lectures on "The Contest between Guns and Armour." The Friday Evening Meetings will be resumed on April 12th, when a Discourse will be given by Professor A. H. Church on "Conservation of Historic Buildings and Frescoes (with Experimental Illustrations)"; succeeding Discourses will probably be given by Professor C. S. Sherrington, James Swinburne, Esq., Sir James Crichton-Browne, Signor Comè Giacomo Boni, Professor G. Chrystal (assisted by E. M. Wedderburn, Esq.), Professor J. A. Fleming, A. H. Savage Landor, Esq., Professor Sir James Dewar, and other gentlemen.

MEETINGS FOR THE WEEK.

TUESDAY, 19th.—Royal Institution, 3. "The Visual Apparatus of Man and Animals," by Prof. William Stirling.
— Society of Arts, 8. "Oils, Varnishes, and Mediums Used in the Painting of Pictures," by A. P. Laurie.
— Faraday Society, 8. "Potential of Hydrogen liberated from Metallic Surfaces," by H. Nutton and H. D. Law. "Electrode Potentials in Liquid Ammonia," by F. M. G. Johnson and N. T. M. Wilsmore. "The Impedence of Solutes in Solvents as manifested by Osmotic 'Pressure,'" by J. G. A. Rhodin. "Electrolytic Deposition of Zinc, using Rotating Electrodes," by T. S. Price.

WEDNESDAY, 20th.—Society of Arts, 8. "Smoke Prevention in Factories and Electric Supply Stations," by J. B. C. Kershaw, F.I.C.
— Microscopical, 8. "Some South African Tardigrada," by James Murray. Exhibition of Specimens of British Mycetozoa, by Alfred E. Hilton.

THURSDAY, 21st.—Royal Institution, 3. "Biology and Progress," by Dr. C. W. Saleeby, F.R.S.E.
— Chemical, 8.30. "Synthesis of Polypeptides," by E. Fischer. "Organic Derivatives of Silicon—Part III., *di*-Benzylmethylethylpropylsilicane and Experiments on the Resolution of its Sulphonic Derivative," by F. S. Kipping. "Reduction of Carbon Dioxide to form Aldehyde in Aqueous Solutions," by H. J. H. Fenton. "Mechanism of the Rusting of Iron," by G. T. Moody. "Some Compounds of Guanidine with Sugars," by S. S. Morrell and A. E. Bellars.

FRIDAY, 22nd.—Royal Institution, 9. "Rays of Positive Electricity," by Prof. J. J. Thomson, F.R.S., &c.
— Physical, 5. "Experimental Mathematics," by Mr. Pochin. "Logarithmic Lazytongs and Lattice Works," by Mr. Blakesley. "A Micromanometer," by Mr. Roberts. "Electrical Conduction produced by Heating Salts," by Mr. Garrett.

SATURDAY, 23rd.—Royal Institution, 3. "Röntgen, Cathode, and Positive Rays," by Prof. J. J. Thomson.

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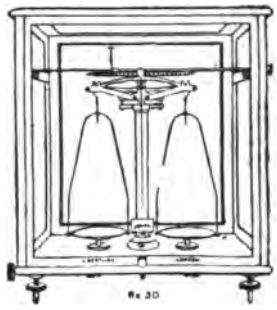

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THE CHEMICAL NEWS.

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EXISTENCE OF AMMONIUM HYDRATE.

By PHILIP BLACKMAN.

IT was shown by the author ("Quantitative Relation between Molecular Conductivities," *Phil. Mag.*, 1906, xi., 416; CHEMICAL NEWS, 1906, xciv., 164) that, at constant temperature,—

$$\mu v_{M_1OH} - \mu v_{M_2OH} = \mu v_{M_1X} - \mu v_{M_2X} = \mu v_{M_1X_1} - \mu v_{M_2X_1} = \mu v_{M_1X_2} - \mu v_{M_2X_2} = \ldots\ldots\ldots\ldots = \text{constant}$$

(in which μv represents the molecular conductivity at concentration v of the bases M_1OH and M_2OH, and of the salts M_1X, M_2X, &c.).

In the case of ammonium hydrate, NH_4OH, and of ammonium salts, NH_4X, NH_4X_1, &c., the above expression is true for the salts only, the quantity $\mu v_{NH_4OH} - \mu v_{M_2OH}$ not being equal to this constant, as is illustrated in Table I. (constructed from the data in Landolt-Bornstein's "Physikalisch-Chemische Tabellen," 1905 edition).

The molecular conductivities of the potassium salts are almost the same as those of the corresponding ammonium salts, and the expression $\mu v_{KX_n} - \mu v_{NH_4X_n}$ is consequently near zero in value. It would be very reasonable to expect that the molecular conductivities of potassium and ammonium hydrates would also have been almost identical in value (when measured under the same conditions of temperature and concentration).

By means of the equation—

$$\mu v_{NH_4OH} = \mu v_{M_2OH} + \mu v_{NH_4X_n} - \mu v_{M_2X_n}$$

it is possible to calculate the "theoretical" molecular conductivities of ammonium hydrate (Table II.).

From an examination of the above facts the following is a most reasonable conclusion:—

If the ammonia in aqueous solution were entirely converted into ammonium hydrate, then the experimental values for the molecular conductivities would be near the calculated theoretical values. But as the experimental values are far below the theoretical ones, we must conclude that the ammonia in aqueous solution exists only partially as ammonium hydrate. Accordingly, the percentage of ammonia existing as ammonium hydrate in aqueous solution is given by the formula—

$$100 \frac{\text{Experimental } \mu v_{NH_4OH}}{\text{Theoretical } \mu v_{NH_4OH}}.$$

By the aid of this formula Table III. has been compiled.

Table IV. is an additional illustration of the foregoing argument and conclusion.

TABLE IV.

v (at 25°) =	512	256	128
$\mu v_{NH_4Cl} - \mu v_{TlCl}$	0·9	1·3	2·5
But $\mu v_{TlOH} - \mu v_{NH_4OH}$	220·5	229·0	230·6
$\mu v_{TlOH} + \mu v_{NH_4Cl} - \mu v_{TlCl}$	248·9	249·3	246·5
Experimental μv_{NH_4OH}	27·5	19·0	13·4
Cf. $\mu v_{NH_4} + \mu v_{OH}$ (CHEM. NEWS, 1906, xciv., 176)	248·0	245·0	244·0
Percentage of NH_4OH	11·0	7·62	5·4

The accompanying tables would seem to indicate that the percentage of ammonia in aqueous solution existing as ammonium hydrate increases with increased dilution. With the present limited data at one's disposal, it is impossible to determine definitely by the preceding method whether rise in temperature causes an increase or diminution in the percentage amount of ammonium hydroxide.

Thus, though ammonium hydrate is theoretically as strong a base (on the electrical conductivity theory) as potassium hydroxide, yet, because of the small quantity of ammonia existing as the hydrate in aqueous solution, it is in practice one of the weakest bases. But this view renders it difficult to explain the great solubility of ammonia in water.

The author is indebted to Prof. Dr. R. Luther, of Leipzig, for the following (from "If one . . . " to " . . . = $K_{Blackman}$"):—

If one grm.-molecule of ammonia be dissolved in water to give v litres of the solution, and the proportion of it converted into ammonium hydrate be denoted by q, the concentrations of the combined ammonia, uncombined ammonia, combined water, and uncombined water are respectively—

$$\frac{q}{v}, \quad \frac{1-q}{v}, \quad \frac{q}{v}, \quad \text{and} \quad 1-\frac{q}{v}.$$

(The letter c denotes "concentration" and K a "constant"). According to the "electrolytic dissociation" theory, $K c_{NH_4OH} = c_{NH_3} \times c_{H_2O}$; since c_{H_2O} is constant, we have—

$$K_h c_{NH_4OH} = c_{NH_3} \quad (K_h = \text{"hydrolytic" constant}). \quad . \quad . \quad 1,$$

$$K_e c_{NH_4OH} = c_{NH_4'} \times c_{OH'} \quad (K_e = \text{"electrolytic" constant}). \quad 2.$$

$$c_{NH_4'} = c_{OH'} = \frac{\mu v}{v \mu_\infty} = \frac{a}{v_{Ostwald}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 3,$$

$$= \text{approximately } \frac{\text{Experimental } \mu v}{v. \text{ Theoretical } \mu v} = \frac{q}{v_{Blackman}} \quad . \quad 3a.$$

$$c_{NH_4OH} + c_{NH_3} = c_{\text{non conducting ammonia}} = \frac{1-a}{v_{Ostwald}} = \text{nearly} \frac{1-q}{v_{Blackman}}$$

$$c_{NH_4OH} + c_{NH_3} = c_{\text{non-conducting ammonia}} = (1+K_h) c_{NH_4OH} \text{ (from Equation 1)} = \frac{1-a}{v_{Ostwald}} = \text{approximately } \frac{1-q}{v_{Blackman}}.$$

$$c_{NH_4OH} = \frac{1-a}{v} \cdot \frac{1}{1+K_h \text{ Ostwald}}.$$

From Equations 2, 3, and 3*a* we obtain—

$$\frac{K_e}{1+K_h} = \frac{a^2}{(1-a)v_{Ostwald}} = K_{Ostwald} = \frac{q^2}{(1-q)v_{Blackman}} = K_{Blackman}.$$

(Prof. Dr. R. Luther has subsequently pointed out to me the analogous work of Prof. Dr. F. Walker, *Journ. Chem. Soc.*, 1903; *Trans.*, lxxxiii., 182. His work above is independent of Dr. Walker's research.—P. B.).

Tables V. and VI. illustrate the similarity between these two constants.

TABLE V.

v (at 18°).	K (Blackman) × 10⁵.	K (Ostwald) × 10⁵.
1000	1·69	1·60
500	1·79	1·86
200	1·79	1·66
100	1·93	1·75
50	2·11	2·34
20	2·25	2·08
10	2·23	1·99
2	2·47	1·69
1	2·51	1·61
Mean	2·09	1·84

TABLE I.

v (at 18°) =	1000	500	200	100	50	20	10	2	1
$\mu_v KCl - \mu_v NH_4Cl$	0·0	0·1	0·2	0·3	0·3	0·5	1·3	1·0	1·3
$\mu_v KNO_3 - \mu_v NH_4NO_3$	0·9	0·4	0·9	0·2	2·2	0·2	1·4	5·1	8·4
$\mu_v \frac{1}{2}K_2SO_4 - \mu_v \frac{1}{2}(NH_4)_2SO_4$								2·9	3·4
$\mu_v KI - \mu_v NH_4I$								0·1	0·5
But $\mu_v KOH \quad \mu_v NH_4OH$	206	203·4	216·8	219·4	217·9	214·4	209·7	195·7	183·1
$\mu_v NH_4Cl - \mu_v NaCl$	20·8	20·7	20·4	20·2	20·0	19·5	18·7	19·1	21·2
$\mu_v NH_4NO_3 \quad \mu_v NaNO_3$	21·7	21·1	19·5	19·8	17·5	18·6	19·4	19·0	21·4
$\mu_v \frac{1}{2}(NH_4)_2SO_4 - \mu_v \frac{1}{2}Na_2SO_4$								19·7	19·8
$\mu_v NH_4I - \mu_v NaI$								22·2	24·4
But $\mu_v NaOH \quad \mu_v NH_4OH$	177	182·9	191	193·6	194·1	194·4	192·1	172·7	156·1
$\mu_v NH_4I - \mu_v LiI$								29·8	32·5
$\mu_v \frac{1}{2}(NH_4)_2SO_4 - \mu_v \frac{1}{2}Li_2SO_4$								22·8	25·7
$\mu_v NH_4Cl - \mu_v LiCl$								30·7	33·6
But $\mu_v LiOH \quad \mu_v NH_4OH$								136·6	124·5

TABLE II.

v (at 18°) =	1000	500	200	100	50	20	10	2	1
$\mu_v KOH + \mu_v NH_4Cl - \mu_v KCl$	234·0	232·9	229·8	227·7	224·7	218·5	211·7	196·0	183·7
$KOH + NH_4NO_3 - KNO_3$	234·9	234·8	229·1	227·8	222·8	219·2	214·8	202·1	192·4
$NaOH + NH_4Cl - NaCl$	225·8	225·2	224·2	223·6	221·1	219·5	214·1	179·8	162·0
$NaOH + NH_4NO_3 - NaNO_3$	226·7	225·6	223·7	223·2	218·5	217·6	214·8	194·5	179·9
$NaOH + NH_4I - NaI$								196·3	181·4
$KOH + NH_4I - KI$								193·2	175·3
$KOH + \frac{1}{2}(NH_4)_2SO_4 - \frac{1}{2}K_2SO_4$								187·7	187·0
$NaOH + \frac{1}{2}(NH_4)_2SO_4 - \frac{1}{2}Na_2SO_4$								188·4	173·8
Average theoretical $\mu_v NH_4OH$	230·1	229·3	226·7	225·6	221·8	218·7	213·8	192·2	179·3
Experimental ,,	28·0	20·6	13·2	9·6	7·1	4·6	3·3	1·35	0·9
Cf. $\mu_v NH_4 + \mu_v OH$ (*Phil. Mag.*, 1906, xii., 150—152)	228	224	222	219	216	210	199	186	172

TABLE III.

v (at 18°) =	1000	500	200	100	50	20	10	2	1
Percentage of NH_4OH ..	12·2	9·0	5·8	4·3	3·2	2·1	1·5	0·7	0·5

TABLE VI.

v (at 25).	K (Blackman) × 10^3.	K (Ostwald) × 10^3.
512	2·66	2·65
256	2·46	2·44
128	2·41	2·37
Mean	2·51	2·49

According to the "law of mass action," we have—

$$c_{\text{uncombined ammonia}} \times c_{\text{uncombined water}} = k \times c_{\text{combined } NH_3},$$

or—

$$\frac{1}{k} = K = \text{constant} = \frac{q}{v}\left(\frac{v}{1-q}\right)\left(\frac{v}{v-q}\right) = \frac{vq}{(1-q)(v-q)}.$$

On performing the calculations, the values for K thus obtained are not the same for different concentrations:—

v (at 18°) =	1000	500	200	100	50	20	10	2	1
$K \times 10^3$ =	13·89	9·89	6·15	4·49	2·39	2·14	1·49	0·7	0·5

v (at 25°) =	512	256	128
$K \times 10^3$ =	12·35	8·25	5·72

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THE OCCLUSION OF THE RESIDUAL GAS BY THE GLASS WALLS OF VACUUM TUBES.*

By A. A. CAMPBELL SWINTON.

USERS of Crookes's tubes for Röntgen ray purposes have for long been aware that, apparently owing to a change in vacuum, the tubes become "harder" with use, and that it becomes necessary in the case of old tubes to heat the glass in order to get the discharge to pass.

In a paper read before the Royal Society in April, 1899 ("On the Luminosity of the Rare Earths when Heated *in vacuo* by means of Cathode Rays," *Proc. Roy. Soc.*, vol. lxv.), the present writer pointed out that the vacuum actually increases in cathode ray tubes with use, even if repeated small doses of additional air be let in from time to time.

Villard has also shown that the residual gas in a vacuum tube is driven into the glass, and that portions of the glass of a tube that has been used show bubbles if heated strongly. Again, in a paper on the absorption of gas in a Crookes's tube by Dr. R. S. Willows (*Phil. Mag.*, April, 1901), a number of experiments relating to this subject are

* A Paper read before the Royal Society, February 28, 1907.

recorded, including one by Professor J. J. Thomson, in which, after admitting small quantities of air and absorbing the same repeatedly, it was found that the weight of the tube had increased by the weight of the air that had been admitted, although after admission the discharge caused the pressure to fall so much that Röntgen rays were given off by the tube.

The present paper describes certain further investigations on this subject.

The tubes first experimented upon were some of those originally employed by the writer in 1898, and referred to in his above-mentioned paper. Since that date they have been lying undisturbed and open to atmospheric pressure, so that the gas now found to be imprisoned in the glass must have been there for some nine years. No note was taken in 1898 as to the amount of time that the tubes were used, but each was in operation for many hours and under extremely severe conditions, the alternating current employed having a volume of some 20 milli-ampères at about 8000 volts pressure.

The condition of the glass walls of these tubes is now found to be as follows:—When cleaned by rubbing they are quite transparent to casual inspection, though careful examination with the microscope shows that the inner surface of those portions that had been subjected to cathode ray bombardment are materially roughened. When these portions of the glass are strongly heated in a blowpipe flame, they immediately become clouded, the effect being due to quantities of minute spherical bubbles in the glass, which may clearly be seen with a microscope. The bubbles vary to some extent in size, but on the average are about 0·01 mm. in diameter. They are usually packed closely together in a single layer, and are always very near the side of the glass that formed the inner surface of the tube. On measuring the thickness of the glass with a micrometer gauge, dissolving the inner surface with hydrofluoric acid until the bubbles had just disappeared, and then again measuring the thickness, it was found that, after making allowance for the size of the bubbles, the centres of these bubbles were about 0·122 mm. from the inner surface of the glass, A similar estimate was obtained by grinding the inner surface of the glass until the bubbles just disappeared, and making micrometer measurements as before. It would therefore appear that the particles of gas must have been shot into the glass to about the depth stated.

In a typical piece of glass the number of bubbles per square centimetre of glass was found to be about 625,000, so that, allowing for the expansion of the gas on heating the glass up to redness, there was occluded about 0·000113 cc. of gas at atmospheric pressure per square centimetre of glass, and as the amount of glass surface that was bombarded in each tube was about 400 sq. cm., the total amount of gas at atmospheric pressure occluded in each tube is nearly 0·05 cc., apart from any further amount that may have escaped from the glass in the heating of the latter.

An interesting question arises as to whether the gas is merely mechanically mixed with the glass or whether there has been any chemical combination between the two. In the latter case, it seemed unlikely that mere powdering of the glass would cause the gas to come out, while in the former case it seemed probable that powdering the glass would have this effect.

In order to test this, a number of pieces of the glass were placed in a chamber consisting of two slightly dished tinned plates some 15 cm. in diameter, which was soldered together all round the edges, with a metal tube inserted, so as to be air-tight. The chamber was connected with a mercury pump and a spectrum tube, and was then pumped until no electric discharge could be got to pass through the spectrum tube. An anvil was then placed under the chamber, and the latter was struck several blows with a hammer so as to powder the glass, when there was an immediate fall of vacuum, and on examination with a spectroscope the gas that had been evolved was found to be mainly hydrogen. The chamber was then pumped out again, and on further blows being struck so as to powder more glass, similar results were obtained; in fact, the process was repeated many times, the result being in each case to bring out more hydrogen.

It would appear therefore that the gas occluded in soda-glass vacuum tubes exhausted in the ordinary manner from air is almost entirely hydrogen, no doubt due to electrolysis of water vapour condensed on the walls of the tube prior to exhaustion, the oxygen of which is absorbed by oxidation of the aluminium electrodes.

In order, further, to determine whether the occlusion of gas in a vacuum tube is in any way due to chemical combination of the gas with the glass, or whether it is purely a case of the gas being driven into the glass and mechanically held there, a suggestion made to the writer by the Hon. R. J. Strutt was followed, and experiments were tried with helium.

A spherical tube of soda-glass about 7 cm. in diameter, with two electrodes consisting of aluminium plates, was employed. The tube was first exhausted in the ordinary way from air until the vacuum was so high that the discharge would not pass, and then, by an arrangement of stop-cocks, a small quantity of helium was admitted. The tube was then sparked, and the vacuum was found to increase, showing that the helium was being absorbed. Further small quantities of helium were admitted at intervals, the process being continued intermittently for twenty days, the total number of hours of sparking being about ninety, or four and a-half hours per day, and the number of admissions of helium about 700, until about 1 cc. of helium at atmospheric pressure had been absorbed.

During the process of sparking the tube gradually blackened, the deposit being afterwards ascertained to be aluminium from the electrodes. There thus seemed some doubt as to whether the helium was being absorbed entirely by the glass or perhaps partly by the very thin coating of aluminium, which, by the time the cc. of helium had been absorbed, had become a perceptible mirror.

On breaking up the tube, however, it was found that whether the glass was heated without further treatment, or whether the mirror of aluminium was first dissolved off its surface with dilute nitric acid, a plentiful supply of bubbles was produced in the glass, showing that at any rate some portion of the helium had found its way into the latter. In appearance the bubbles were very similar to those that had been found in the tubes that had occluded hydrogen, only, as a rule, the bubbles were more numerous and considerably smaller in diameter. Furthermore, as a rule, they tended to be gathered together in groups, and were not evenly distributed over the glass as in the case of hydrogen. Under these circumstances, it was very difficult to estimate the quantity of gas occluded in the glass. It was certainly much less than in the case of hydrogen, and only a fraction of the 1 cc. occluded altogether. The remainder would seem not to have been driven far enough into the glass to form bubbles, but to have escaped from the surface on the glass being heated.

Similar experiments were made with the glass containing helium to those tried with the glass containing hydrogen, in the way of extracting the gas by powdering the glass in a vacuum chamber. It was found impossible to get rid altogether of the hydrogen spectrum and other faint lines, due, no doubt, to impurities, but, on the glass being powdered, the helium spectrum was found to be clearly superposed. This was equally the case when glass that was still coated with the aluminium deposit was used as with glass from which this deposit had been dissolved off. Consequently, the occlusion appears to take place entirely in the glass.

Seeing that helium does not combine with anything at ordinary temperatures, and seeing further that it could be extracted from the glass by the mere mechanical powdering of the latter, it would appear that the occlusion is due to the mechanical driving of the gas into the glass and not to any chemical combination.

The writer is indebted to Mr. J. C. M. Stanton and Mr. R. C. Pierce for their assistance in carrying out the investigations.

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 128).

Procedures and Notes (continued).

Procedure 5. (For an alternative procedure, see N. 7 below and P. 8).—Transfer to a platinum crucible the residue after treatment with acids (P. 2 or P. 4), add 2 cc. H_2SO_4 (1·84) from a graduate, heat with a moving flame until white fumes are given off, and cool completely. To test for silica, add carefully (see N. 1) from the loop of a platinum wire pure 40 per cent HF drop by drop until 5 to 6 drops have been added, and warm the mixture over a steam-bath. (Formation of gas bubbles, presence of *silica*).

Then add about 5 cc. more pure 40 per cent HF, cover the crucible with a platinum cover, digest on a steam-bath for about fifteen minutes unless the residue dissolves more quickly; remove the cover and evaporate carefully until white fumes of H_2SO_4 are given off, heating the sides of the crucible with a moving flame—or, better, with a ring-burner to avoid spattering. (Unless it is known from the presence of solid substance at this point or from previous observations that the residue treated with H_2SO_4 and HF contained other constituents than silica, determine this by evaporating off the H_2SO_4 under a hood, taking care not to ignite the residue. If a significant residue remains, add from a graduate 1·5 cc. H_2SO_4 (1·84), and heat until the residue is re-dissolved, not allowing the acid to evaporate). Cool, pour the contents of the crucible into 10 cc. water, and rinse out the contents with a little water. Boil to dissolve slowly-dissolving sulphates; cool, shake, filter, and wash the residue, first with H_2SO_4 (1·20) and then with a little water, rejecting the washings. (Residue, P. 6). To the filtrate add HCl drop by drop only as long as a precipitate forms; filter, wash the precipitate, and test it for silver by P. 15. Dilute the filtrate to a volume of 40 cc., treat it with H_2S by P. 21, subsequently testing for all the metallic elements except lead, barium, and strontium.

Notes.

1. Great care must be taken not to breathe the fumes of HF nor to get it on the hands; for it is very irritating and produces dangerous burns.

2. The test for silica or silicate depends on the formation of SiF_4 gas, which is insoluble in strong H_2SO_4, but dissolves in water in the presence of HF with formation of fluosilicic acid, H_2SiF_6. With free silica the evolution of gas takes place in the cold; but with slowly decomposing silicates, such as felspar, the test is obtained only upon warming. A few silicates are not acted upon by HF and H_2SO_4, and of course do not show the test for silica at this point. The test is delicate enough to enable 1 mgrm. of silica, whether free or in a decomposable silicate, to be detected. Moreover, after the substance has been treated with acids as in P. 4 and warmed with H_2SO_4, an evolution of gas with HF is not produced with the compounds of any element other than silicon (not even with those of titanium, niobium, and tantalum, which form somewhat volatile fluorides). It should be borne in mind that a small quantity of silica will be introduced if ordinary filters (which have not been washed with HF) have been employed and have been destroyed by acids or by ignition, or if a strongly alkaline solution has been boiled in glass vessels, or if a substance has been fused with sodium carbonate in a porcelain crucible.

3. Since glass and porcelain consist of silicates which are readily attacked by HF, this acid must not be allowed to come into contact with these materials. In handling cold HF solutions, vessels and funnels of celluloid or paraffin or of glass coated with paraffin may be used; but platinum vessels must be employed when the solutions are to be heated. Care must be taken not to introduce into a platinum vessel any solution containing chlorine or bromine or any acid mixture containing nitrates and chlorides by which chlorine would be evolved. Platinum is so slowly attacked by hot concentrated H_2SO_4 that even when 2 to 3 cc. of the acid are rapidly evaporated in a crucible less than half a milligrm. passes into solution; but, if the acid is boiled for ten to fifteen minutes in a covered vessel, 2 or 3 m.grms. may be dissolved, and would be precipitated subsequently by H_2S.

4. The digestion with HF decomposes most silicates and dissolves silica (and much titanium oxide). The subsequent evaporation with H_2SO_4 expels the excess of HF and decomposes the fluorides produced, as well as some other substances that may have been left undissolved by the HNO_3 and HCl. The H_2SO_4 solution is diluted with a small quantity of water, so as to cause the complete precipitation of $BaSO_4$, $SrSO_4$, and $PbSO_4$. These sulphates are moderately soluble in strong H_2SO_4 and may not appear till after dilution. The addition of much water is avoided, since $SrSO_4$ and $PbSO_4$ are somewhat soluble in water; and the residue is washed with dilute H_2SO_4 for the same reason. The solution is boiled so as to dissolve anhydrous sulphates, such as those of aluminium and iron.

5. The residue insoluble in dilute H_2SO_4 contains as sulphates all the barium, strontium, and lead, and all of the calcium in excess of 5 to 10 mgrms. left undissolved by HNO_3 and HCl; more or less of the chromium (according as the H_2SO_4 has been more or less strongly heated) as a pink anhydrous sulphate; and part of the bismuth as basic sulphate and antimony as antimonic hydroxide, when much of these elements were left undissolved by the previous treatments with acids. The residue may also contain still undecomposed substances, especially the following:—Silver chloride; corundum, Al_2O_3; chromite, $FeCr_2O_4$; cassiterite, SnO_2; rutile, TiO_2; tungstic oxide, WO_3; molybdenum sulphide, MoS_2; some anhydrous silicates and fluosilicates, such as cyanite or andalusite (Al_2SiO_5) and tourmaline; graphite and carbides.

6. If the presence of silver is shown by the addition of HCl, the residue insoluble in dilute H_2SO_4 is likely to still contain AgCl, which is only slowly decomposed by hot concentrated H_2SO_4. In order to dissolve this, add to the residue in a small casserole 3 to 5 cc. concentrated H_2SO_4, heat until white fumes are given off, cover the dish with a large watch-glass, and boil gently for five to ten minutes. Cool, and treat as described in the last paragraph of the above procedure. If AgCl is not completely removed in this way, its presence will be shown by a blackening of the residue upon boiling with Na_2CO_3 solution in P. 6; in such a case it must be removed by further treatment with H_2SO_4 before a fusion with Na_2CO_3 is made in a platinum crucible (P. 7). By this treatment with boiling H_2SO_4, Al_2O_3 and TiO_2, if present in the residue, are also dissolved in large quantity.

7. If the use of a platinum crucible or of hydrofluoric acid is impracticable, the residue insoluble in HCl and HNO_3 may be fused in a porcelain crucible with a mixture of Na_2CO_3 and K_2CO_3, as described in P. 8, instead of being treated by P. 5—7. This is, however, a far less satisfactory method of analysis, for the following reasons:—Compounds of the alkali elements are used as a flux, and aluminium, calcium, and silica are introduced from the porcelain crucible, so that these elements can-

* From the *Technology Quarterly*, xix., No. 3, September, 1906.

not be tested for in the insoluble residue. Moreover, the treatment with HF and H_2SO_4 is almost always a shorter process, since when the residue consists only of silica, as is often the case with minerals, no further treatment is necessary, and since in other cases there is often no residue to be boiled with Na_2CO_3 solution (P. 6) and seldom one to be fused with Na_2CO_3 (P. 7). A fusion in a platinum crucible with alkali metal carbonate would be less objectionable; but this is not possible unless reducible metallic elements are known to be absent in the residue (see P. 7, N. 1).

Procedure 6.—Transfer the residue insoluble in H_2SO_4 (P. 5) to a casserole, add about 25 cc. saturated Na_2CO_3 solution (see, however, *P 6*a*, N. 1, if a small quantity of tungsten is to be tested for), cover the casserole, and boil gently for ten minutes. Filter and wash the residue thoroughly. Filtrate, reject or test for tungsten by *P. 6*a*). Heat the residue with 5 cc. HCl (1·12), measured in a graduate, and 10 cc. water; filter, wash the residue, and treat it by P. 7. Dilute the solution to 40 cc., and treat it with H_2S by P. 21, subsequently testing it only for lead, bismuth, antimony, chromium, barium, strontium, and calcium.

Notes.

1. The boiling with Na_2CO_3 converts into carbonates the sulphates of lead, calcium, strontium, and bismuth completely, and at least 80 per cent of the sulphate of barium, even when large quantities of them are present. A second treatment, which should be applied to the residue if there are indications that barium is present, completely decomposes $BaSO_4$. The carbonates dissolve readily in HCl. Anhydrous chromic sulphate, which is left undissolved by dilute H_2SO_4 (P. 5) as a fine pink or grey powder, is slowly changed by boiling with Na_2CO_3 to a greenish blue hydroxide which dissolves in the HCl, leaving behind the still undecomposed sulphate. Antimonic oxide dissolves only to a small extent (2 to 4 mgrms.) in the Na_2CO_3 solution, but dissolves upon boiling with HCl. Tungstic oxide passes into the Na_2CO_3 solution as sodium tungstate, Na_2WO_4.

2. Any residue insoluble in HCl can therefore consist only of barium and chromic sulphates or of some of the original substance still undecomposed, consisting probably of one of the native oxides or silicates mentioned in P. 5, N. 5. Such a residue will seldom be obtained; and if so, it can ordinarily be rendered soluble by fusion with Na_2CO_3 and KNO_3 (or with KOH) as described in P. 7 (or P. 7, N. 2).

3. The residue undissolved by dilute H_2SO_4 after the treatment with HF (P. 5) is first boiled with Na_2CO_3 solution and not at once fused, since it is necessary to remove the reducible metals—lead, bismuth, and antimony—before a platinum crucible can be used for the fusion. Moreover, the boiling with Na_2CO_3 solution makes subsequent fusion unnecessary when the residue consists only of sulphate of lead or of an alkaline earth element.

**Procedure* 6*a*.—Acidify the Na_2CO_3 solution (P. 6) with HNO_3, evaporate almost to dryness, add 1 to 2 cc. HNO_3 (1·20); add enough water to dissolve the salt, boil, and cool. (Yellow precipitate, presence of *tungsten*). Filter and wash the precipitate, rejecting the solution. Pour through the filter 2 cc. NH_4OH (0·96) to dissolve any H_2WO_4, acidify the filtrate with HCl (1·20), and add a few granules of zinc. (Blue colour, presence of *tungsten*).

Notes.

1. When HNO_3 is added to a tungstate solution a hydrated tungstic acid separates as a white flocculent precipitate, which changes upon boiling to a yellow powder (H_2WO_4). The test is not very delicate in the presence of a large amount of salt; when 25 cc. Na_2CO_3 solution are used, as is directed in P. 6, even 3 mgrms. of tungsten can barely be detected in this way. Therefore, when tungsten is to be tested for, the residue from P. 5 should first be boiled with a small portion (5 cc.) of Na_2CO_3 solution, and this solution tested for tungsten as described above; under these conditions 1 mgrm. can be detected. The test is entirely unsatisfactory if H_2SO_4 or HCl is used, in place of HNO_3, in neutralising the Na_2CO_3.

2. The blue colour obtained upon reduction with zinc, which serves as a confirmatory test for tungsten, is due to a suspended, quickly coagulating precipitate, consisting of a hydrated oxide intermediate between WO_3 and WO_2. Prolonged action of zinc may cause the blue colour to disappear, owing to complete reduction to WO_2.

3. At this point will usually be found all the tungsten in the substance in excess of 2 mgrms., which amount remains in solution in the H_2SO_4 (P. 5). When, however, phosphate is also present in the substance, tungsten would not remain as H_2WO_4 in P. 3 and 4, but would pass into the acid solution, owing to the formation of a complex phospho-tungstic acid.

Procedure 7.—Transfer the residue insoluble in HCl (P. 6), with the filter if necessary, to a platinum crucible, heat until the residue is dry or until the filter is destroyed, mix the residue with 5 to 10 grms. of anhydrous Na_2CO_3 and 0·1 to 0·5 grm. of solid KNO_3, cover the crucible, and heat over a powerful burner. After some minutes note whether a perfectly fluid fusion has resulted. If not, heat more intensely over a blast-lamp for ten minutes, adding, if necessary, more Na_2CO_3. Cool, place the crucible in a casserole, add carefully HCl (1·12) till the solution remains strongly acid, evaporate to dryness, and heat at 120—130° to render silica insoluble; add from a graduate 4 cc. HCl (1·12) and 10 to 20 cc. water, boil, and filter. Dilute the filtrate to 40 cc., and treat it with H_2S by P. 21, subsequently testing it for all metallic elements except the alkalis. Test the residue for silica by P. 5, and remove it if present; if a residue still remains, treat it as described in N. 3.

Notes.

1. Compounds of the elements of the silver, copper, and tin groups that may be reduced to the metal by heating with an alkaline flux must not be heated in platinum. The same is true of sulphur, sulphides, and in the presence of organic matter of phosphates; for all these elements form easily fusible alloys with the platinum, and thus spoil the crucible. If, however, the substance has been treated by the preceding procedures, none of these substances can be present. Moreover, alkaline hydroxides and strongly oxidising fluxes (such as peroxides and nitrates) must not be fused in platinum, since they attack it fairly rapidly. Therefore, no more nitrate should be added to the Na_2CO_3 fusion than is necessary.

2. In regard to the decomposition of substances in general by fusion with Na_2CO_3, see P. 8, N. 1. Of the substances that may be present in the residue which has been boiled with Na_2CO_3 solution, the silicates are decomposed by fusion with Na_2CO_3 alone. But in order to render chromium compounds (and molybdenum sulphide) soluble, they must be oxidised; and for that purpose a little KNO_3 is added. The native and ignited oxides of tin, aluminium, and titanium are only slowly acted upon by the flux, and remain insoluble with the silica upon the subsequent treatment with acid. $BaSO_4$, if still present, will also remain with the silica; for, though it is converted into $BaCO_3$ and Na_2SO_4 by the fusion, it is formed again when the mass is treated with acid.

3. Any residue insoluble in dilute HCl probably consists, therefore, only of SiO_2, TiO_2, $BaSO_4$, Al_2O_3, and SnO_2. Such a residue is best treated first by P. 5 and 6, to remove SiO_2 and $BaSO_4$, and any residue still remaining may then be treated as follows:—Reduce it to a very fine powder, transfer it to a nickel or silver crucible, dry thoroughly, add 5 to 10 grms. pure solid

KOH, and fuse the mixture for ten to twenty minutes. Cool, extract with about 30 cc. water, and filter. Neutralise the solution exactly with HCl (1·12). Treat the residue with about 5 cc. HCl (1·12), filter out any residue of undecomposed substance, and unite the solution with the neutral aqueous extract. Treat the mixture by the regular procedure beginning with P. 21, testing especially for tin, titanium, and aluminium. The native and ignited oxides of aluminium, stannic tin, and titanium, if finely powdered, dissolve rapidly in fused KOH; and the aqueous extract contains the aluminium as aluminate and most of the tin as stannate. The residue undissolved by water may consist of black nickel oxide from the crucible, stannic hydroxide, potassium titanate, and sometimes other hydroxides accompanying the aluminium or tin oxides. All of these dissolve in HCl.

(To be continued).

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Ordinary Meeting March 7th, 1907.

Prof. R. MELDOLA, F.R.S., President, in the Chair.

MESSRS. Frank Baker, F. S. Benton, L. H. Berry, F. J. Harris, A. T. King, B. D. Porritt, F. G. P. Remfry, A. H. Salway, and Frank Tutin were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. John Arthur Cunningham, B.A., Presidency College, Calcutta, India; Samuel Duckworth, M.Sc., 78, Alexandra Road, Lowestoft, Suffolk; Arthur George Harrington, Rochford, Westbury Road, Ealing, W.; Frederic William Rixon, M.Sc., Ph.D., Powderham Road, Newton Abbott, Devonshire; William Griffiths Tonner, B.Sc., 26, Gordon Road, Kingston-on-Thames.

The CHAIRMAN read the names of the Fellows recommended by the Council for election as official and ordinary Members of Council, and announced that the name of Mr. F. H. Streatfeild had been proposed by another Fellow as an ordinary Member of Council.

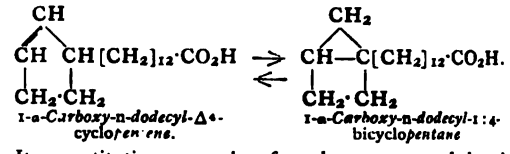
Of the following papers, those marked * were read :—

*50. *The Constitution of Chaulmoogric and Hydnocarpic Acids.*" By MARMADUKE BARROWCLIFF and FREDERICK BELDING POWER.

In previous communications (Power and Gornall, *Trans.*, 1904, lxxxv., 838, 851) the isolation and properties of chaulmoogric acid, $C_{18}H_{32}O_2$ (m. p. 68°) were described. It is optically active, having $[\alpha]_D$ +56°, and was shown to contain both a closed ring and an ethylenic linking.

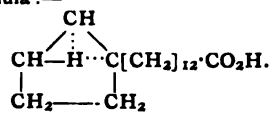
When chaulmoogric acid is oxidised in alkaline solution with limited quantities of potassium permanganate it yields *α-dihydroxydihydrochaulmoogric acid*, $C_{18}H_{32}O_2(OH)_2$ (m. p. 105°; $[\alpha]_D$ +11·6°), *β-dihydroxydihydrochaulmoogric acid*, $C_{18}H_{32}O_2(OH)_2$ (m. p. 93°; $[\alpha]_D$ −14·2°), and *hydroxyketodihydrochaulmoogric acid*, $C_{18}H_{32}O_4$. Further oxidation gives, on the one hand, an optically inactive tricarboxylic acid, $C_{18}H_{32}O_6$ (m. p. 68°), which is n-*pentadecane-αα'γ-tricarboxylic acid*, $CO_2H\cdot[CH_2]_2\cdot CH(CO_2H)\cdot[CH_2]_{12}\cdot CO_2H$, and, on the other hand, formic acid and a keto-acid, $C_{17}H_{30}O_5$, previously described (*loc. cit.*), which is now shown to possess the formula $CO_2H\cdot[CH_2]_2\cdot CO\cdot[CH_2]_{12}\cdot CO_2H$. The latter compound, on oxidation, yields *n*-dodecanedicarboxylic acid, $[CH_2]_{12}(CO_2H)_2$, and *n*-undecanedicarboxylic acid, $[CH_2]_{11}(CO_2H)_2$. By the addition of hydrogen bromide to chaulmoogric acid, and its subsequent elimination, an optically active mixture of acids is obtained, which, when oxidised, furnishes a keto-acid, $C_{18}H_{32}O_5$ (m. p. 126°), to which the formula, $CO_2H\cdot CH_2\cdot CHMe\cdot CO\cdot[CH_2]_{12}\cdot CO_2H$, is acribed.

The results obtained can be explained by assigning to chaulmoogric acid both the following formulæ, and considering it to exist in a state of tautomerism between the two structures.

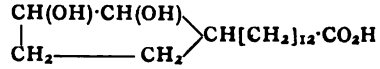


1-α-*Carboxy-n-dodecyl-Δ*⁴-*cyclopentene.* 1-α-*Carboxy-n-dodecyl-1:4-bicyclopentane*

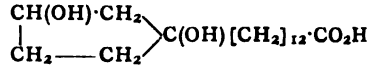
Its constitution may therefore be represented by the following formula :—



To the dihydroxydihydrochaulmoogric acids the formulæ:

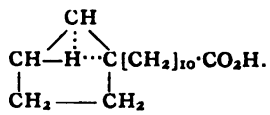


and—



are ascribed, whilst dihydrochaulmoogric acid, $C_{18}H_{34}O_2$, is considered to be a mixture of *α-carboxy-n-dodecylcyclopentane*, and i-*α-carboxy-n-dodecyl-2-methylcyclobutane*.

Hydnocarpic acid, $C_{16}H_{28}O_2$ (m. p. 60°; $[\alpha]_D$ +68°), a homologue of chaulmoogric acid (*Trans.*, 1905, lxxxvii., 884), yielded on oxidation an acid, $C_{16}H_{28}O_6$ (m. p. 60°), which is n-*tridecane-αα'γ-tricarboxylic acid*, $CO_2H\cdot[CH_2]_2\cdot CH(CO_2H)\cdot[CH_2]_{10}\cdot CO_2H$, together with *n*-decanedicarboxylic acid, $[CH_2]_{10}(CO_2H)_2$. Its constitution may accordingly be represented by the following formula :—



*51. "*Hydrolysis of Amygdalin by Acids.*" By ROBERT JOHN CALDWELL and STEPHEN LEWIS COURTAULD.

With the object of obtaining further evidence as to the constitution of amygdalin, the authors have systematically studied the action of acids in comparison with that of enzymes on this "bioside."

The results show that, although amygdalin is ultimately resolved by acids into hydrogen cyanide, benzaldehyde, and two molecular proportions of glucose, the separation of the glucose is effected in two stages. The hydrolysis of the biose section of the molecule proceeds only at about one-sixth of the rate at which maltose is hydrolysed under like conditions. By carefully hydrolysing amygdalin by means of a normal solution of hydrogen chloride at 60°, the authors have prepared the mandelonitrile glucoside which E. Fischer obtained by subjecting the bioside to the action of an extract of yeast; this method of obtaining the glucoside appears to be in some respects advantageous, the product being more easily purified.

*52. "*Mandelonitrile Glucosides. Prulaurasin.*" By ROBERT JOHN CALDWELL and STEPHEN LEWIS COURTAULD.

In order to ascertain whether the glucoside prepared by hydrolysing amygdalin is a direct product or one which has undergone isomeric change, the authors have subjected it to the action of alkalis; they find that it is converted into a substance identical with the isomeric substance prulaurasin, isolated by Hérissey from laurel leaves. Fischer's glucoside therefore bears the same relation to

prulaurasin as amygdalin bears to the *iso*amygdalin described by Dakin, which is to be regarded as the derivative of inactive mandelonitrile, amygdalin and Fischer's glucoside being derived from *l*-mandelonitrile. As the rotatory power of prulaurasin is intermediate between that of Fischer's glucoside and that of sambunigrin, the second isomeride of Fischer's glucoside recently described by Bourquelot and Danjou, the latter must be regarded as the β-glucoside of *d*-mandelonitrile.

Characteristic acetyl derivatives have been prepared from amygdalin, *iso*amygdalin, Fischer's glucoside, and prulaurasin.

*53. "*The Hydrolysis of Amygdalin by Emulsin.*" By SAMUEL JAMES MANSON AULD.

Although amygdalin is generally described as the maltoside of benzaldehydecyanohydrin since on hydrolysis it produces two molecules of dextrose, it is probable that the biose residue is an unknown αβ-disaccharide capable of hydrolysis both by emulsin and maltase.

The hydrolysis of amygdalin by emulsin may proceed in three ways, depending on the mode of attachment of the emulsin. Either mandelonitrile glucoside and dextrose are first produced with subsequent hydrolysis of the former, or benzaldehydecyanohydrin and the αβ-disaccharide are formed, and the latter then resolves into two molecules of dextrose, or, lastly, the amygdalin may undergo fission into the three components by direct abstraction of the dextrose residue attached to the benzaldehydecyanohydrin molecule, The experiments so far carried out indicate that the second process of cleavage is the true one.

DISCUSSION (on the three foregoing papers).

Dr. MCKENZIE asked whether two mandelonitrile glucosides had been obtained, where the relationship is similar to that which exists between amygdalin and *iso*amygdalin, and, further, if the mandelonitrile glucoside described was racemic as regards the mandelic complex, had the fractional hydrolysis of this compound been studied?

Dr. HENRY stated that the report on "Cyanogenesis in Plants," prepared by Professor Dunstan and himself for the York Meeting of the British Association, was mainly a compilation of the published information then available on the subject, and consequently the reference there to amygdalin as a derivative of maltose did not commit the authors of the Report to that view of the constitution of the biose residue of the glucoside and, in fact, the nature of the sugar residue of amygdalin was then under investigation by Dr. Auld, who had been associated recently with the authors in their work on cyanogenetic glucosides.

The interest shown of late in this subject had been created by the work done at the Imperial Institute since 1900, and it had been the intention of Professor Dunstan and himself to investigate fully the relationship of Fischer's mandelonitrile glucoside to prulaurasin and sambunigrin. In view of the fact that Professor Dunstan and he were well known to be at work in this field, it was unfortunate that Messrs. Caldwell and Courtauld had, without consultation, commenced work on these three isomerides.

Dr. AULD regretted that he was not aware that this investigation had been undertaken, as he had been at work on the problem of the constitution of the biose residue of amygdalin for some time. It was an entirely erroneous assumption that the maltose structure of this residue had been taken for granted. Dr. Henry's article in *Science Progress* (July, 1906) clearly showed that the exact nature of the sugar residue in these glucosides had not been settled. The results of Messrs. Caldwell and Courtauld's communication did not throw much new light on the actual configuration of the biose residue.

*54. "*Electrolytic Reduction.*" (Part III.). By HERBERT DRAKE LAW.

The products of electrolytic reduction of the aromatic aldehydes in alkaline solution are compounds of the hydrobenzoin type, but this reaction is completely altered when a methyl group is substituted in the ortho- or meta-position of the benzene nucleus. In the latter case, compounds of a resinous nature are obtained. Thus *p*-tolualdehyde gives a well-defined crystalline substance, whilst *m*- and *o*-tolualdehydes yield nothing but resins. The resinifying effect of a single substitution may, however, be neutralised by the introduction of a second group in a similar position on the opposite side of the nucleus. Thus with 3 : 5-dimethylbenzaldehyde a crystalline product is obtained, whilst 2 : 4-dimethylbenzaldehyde yields 40 per cent of resin. Similar results were given by other aldehydes.

In acid solution, the products differed greatly at different temperatures. Thus in cold solutions primary alcohols were obtained to a large extent, but at 40° the product was of the hydrobenzoin type. Stilbenes and saturated hydrocarbons were also obtained.

DISCUSSION.

The PRESIDENT asked whether, in writing the formulæ of the aromatic aldehydes sometimes with the Kekulé benzene ring and at others with the "centric" arrangement of bonds, the author intended to convey the idea that the Kekulé formula represented the benzene molecule as unsaturated, and the "centric" formula as saturated.

Mr. LAW, in reply, said that the concentric formula best represents the constitution of the benzene nucleus. The introduction of a strain across the molecule distorts this configuration, the greatest mechanical effect being produced for a substitution in the ortho-position. In the latter case, Kekulé's formula probably nearly represents the state of the molecule. Between these two extremes it is possible that many other forms may exist.

*55. "*New Cerium Salts.*" By GILBERT THOMAS MORGAN and EDWARD COHEN.

Although in many cases the cerous salts of carboxylic acids, such as the cinnamate, are insoluble, uncrystallisable substances, it has now been shown that the aromatic sulphonates of this element are usually soluble crystalline compounds resembling the thorium sulphonates previously described by one of the authors (*Abstr.*, 1904, i., 892). A representative series of these cerous sulphonates has been prepared together with several other salts of inorganic and organic acids.

DISCUSSION.

Dr. POWER called attention to the formula of cerium oxalate, which Dr. Morgan had referred to as being $Ce_2(C_2O_4)_3,9H_2O$, and stated that an investigation of this salt, conducted some years ago by Mr. Frank Shedden and himself (*Journ. Soc. Chem. Ind.*, 1900, xix., 636) had conclusively shown that it contains 10 molecules of water. It was thus perfectly analogous in composition to the oxalates of lanthanum and didymium, which may be represented by the general formula $R'''_2(C_2O_4)_3,10H_2O$.

Dr. MORGAN stated that he had, quite incidentally, represented cerous oxalate as $Ce_2(C_2O_4)_3,9H_2O$, as this appeared to be the accepted formula for this well known salt, and was thus given in current works on pharmacy. He had not noticed Dr. Power's correction which showed that the oxalate was in reality a decahydrate, $Ce_2(C_2O_4)_3,10H_2O$.

56. "*Volume Changes which accompany Transformations in the System* $Na_2S_2O_3 : 5H_2O$." By HARRY MEDFORTH DAWSON and COLIN GYRTH JACKSON.

The changes which take place in the system $Na_2S_2O_3 : 5H_2O$ when subjected to certain temperature variations have been investigated by the dilatometric method. Volume temperature curves which indicate the relationship of the various forms of the system were described. At a temperature of 25° the system has been obtained in the following six forms, each characterised by a definite volume:—(1) Primary pentahydrate, (2) secondary pentahydrate, (3) secondary tetrahydrate and saturated solution, (4) primary pentahydrate and saturated solution, (5) secondary monohydrate and saturated solution, (6) liquid.

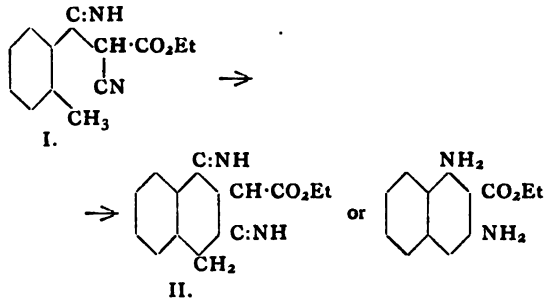
With an accurately calibrated dilatometer the volume occupied by the supercooled liquid of the composition $Na_2S_2O_3 : 5H_2O$ can be directly compared with the volumes of the primary and secondary pentahydrates, and the specific gravities of these obtained with considerable accuracy. The transformation of the metastable secondary pentahydrate into the stable primary form affords an interesting lecture experiment.

57. "*Depression of the Freezing-point of Aqueous Solutions of Hydrogen Peroxide by Potassium Persulphate and other Compounds.*" By THOMAS SLATER PRICE.

Potassium persulphate causes a less molecular depression of the freezing-point of aqueous solutions of hydrogen peroxide than it does of water, and the conclusion is drawn that an unstable compound is formed in solution (compare Friend, *Trans.*, 1906, lxxxix., 1092); similar results hold for potassium sulphate and hydrogen peroxide. In the case of sulphuric acid the molecular depression of hydrogen peroxide solutions is greater than that of water; this confirms the results of Jones and Murray (*Am. Chem. Journ.*, 1903, xxx., 205), that sulphuric acid is dissociated to a greater extent in aqueous hydrogen peroxide than in water. Potassium-hydrogen sulphate and hydrogen peroxide interact in concentrated solution with the production of potassium permonosulphate—no potassium persulphate, $K_2S_2O_8$, is formed—but it was not possible to obtain the pure salt. It was pointed out that a solution of potassium permonosulphate, in the presence of free acid, is much more stable than has been hitherto supposed.

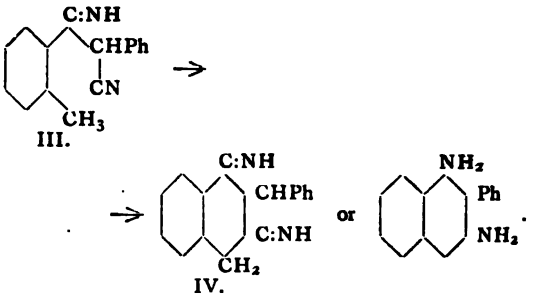
58. "*The Formation and Reactions of Imino-compounds.* Part III. *The Formation of* 1 : 3-*Naphthylenediamine and its Derivatives from* o-*Toluonitrile.*" By ERNEST FRANCIS JOSEPH ATKINSON, HARRY INGHAM, and JOCELYN FIELD THORPE.

In Part II. of this series it was shown that derivatives of benzene containing a saturated side chain of three carbon atoms substituted in the α-position by the nitrile group and in the β-position by the imino-group pass on treatment with cold concentrated sulphuric acid into derivatives of 1 : 3-naphthylenediamine. The authors have now applied this reaction to those derivatives of benzene which possess a saturated side chain of two carbon atoms substituted in the α-position by a nitrile group and in the β-position by an imino-group, and which contain a methyl group in the benzene ring in the ortho-position in respect to the side chain. The two compounds chosen to illustrate this generalisation were ethyl β-imino-α-cyano-β-*o*-tolylpropionate (I.), which was found to be quantitatively converted into ethyl 1 : 3-naphthylenediamine-2-carboxylate (II.) on being dissolved in cold concentrated sulphuric acid :—



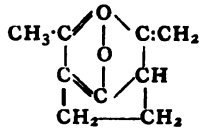
and β-imino-α-cyano-α-phenyl-β-*o*-tolylethane (III.), which under the same conditions passed into into 1 : 3-diamino-2-phenylnaphthalene (IV.).

Evidence was also brought forward indicating that the closing of the ring, both in the present instances and also in those dealt with in Part II., is due to the formation of a definite addition product formed by the action of concentrated sulphuric acid on the nitrile group.

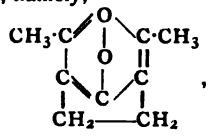


59. "*The Action of Ethylene Dibromide and of Propylene Dibromide on the Disodium Derivative of Diacetylacetone.*" By ALEXANDER WILLIAM BAIN.

By the action of ethylene dibromide on anhydrous disodium diacetylacetone, the author has isolated a *compound* having the formula $C_9H_{10}O_2$, to which he ascribes the constitution—

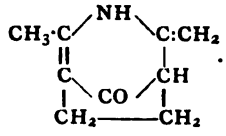


This substance melts at 62—63°, and possesses the remarkable faculty of undergoing isomeric change to a pyrone derivative, namely,—



when heated with concentrated hydrochloric acid. The *hydrochloride* and *platinichloride* of this derivative have been prepared and analysed.

Ammonia reacts with the compound to give—



Similar derivatives have been prepared by the action of propylene dibromide, but both alkyl and alkylene halides of higher molecular weight react with great difficulty and then only to give very unstable compounds.

NOTICES OF BOOKS.

A History of Chemical Theories and Laws. By M. M. PATTISON MUIR, M.A. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1907.

WHILE few students can spare very much time for reading the history of chemistry, it is universally recognised that if they lack definite ideas concerning its development and growth their knowledge cannot but be incomplete, for a good grasp of the science as it now stands can only be obtained by the study of its main achievements in the past. This book provides exactly what the average student requires as a foundation for his reading in the principles of theoretical chemistry. It discusses the history, not of individual substances or groups of substances, but of men's ideas about them, explaining very clearly the errors and false reasonings of earlier days. Long quotations are made from the works of the great masters, and biographical notices are occasionally inserted in which the author con-

tives by his graphic style to convey vivid impressions of the personalities of the men and the value of their work. The book is divided into two main divisions. In the first the growth of knowledge concerning the true nature of a homogeneous substance is traced from the earliest times to the present day, and in the second is described the investigation of correct scientific methods of classifying homogeneous substances, with a view to the discovery of what happens when substances react; in this part the history of the general laws of chemical change is discussed. The physical side of chemistry is treated very scantily, but the author deserves the gratitude of all students whom the spirit of inquiry will not allow to rest satisfied with the statement of definitions and laws without making an endeavour to get at some idea about the process of evolution which modern theories have passed through. By studying this work they will trace the genealogy of the questions which are now stirring in the minds of investigators, and will perhaps be able to form some conception of how their speculations will be answered and what will be the outcome of the development in the future of theories and laws which are now provisionally accepted.

Poisons: their Effects and Detection. By ALEXANDER WYNTER BLYTH, M.R.C.S., F.I.C., F.C.S., &c., and MEREDITH WYNTER BLYTH, B.A. (Cantab), B.Sc. (Lond.), F.I.C., F.C.S., &c. Fourth Edition. London: Charles Griffin and Co., Ltd. 1906.

IT would be superfluous to call attention to the special merits of so well known a work as this compendium, and it will be sufficient to point out the alterations and improvements which have been made in the recently issued fourth edition. Descriptions of obsolete and unsatisfactory processes have been deleted to make room for full accounts of the detection, and physiological action of, and symptoms produced by, some poisons, such as sulphonal, which are beginning to come into use, and the section on arsenic has also been much enlarged, fresh methods of identification and determination being described. The chemical constitution of some vegetable poisons is discussed in outline, and the whole book is so thoroughly practical and up to date that toxicologists will find it a most useful and trustworthy guide.

Internal Energy. By JOHN V. V. BOORAEM, M.E. New York: McGraw Publishing Company. 1906.

THE author of this monograph believes that he has discovered a method of estimating the amount of chemical energy stored within a body. His hypothesis is based upon the measurement of chemical change by expansion through heat, and the measurements were first taken with copper and iron, and were then extended to other metals. It cannot be denied that the calculated results in some cases at any rate show a very good agreement with the values obtained experimentally, but the figures, although they show the main line of the argument, are insufficient to establish the truth of the hypothesis, and the monograph suffers from the disadvantage that the wording is so obscure in places that it is difficult to discern the author's meaning.

Principles and Practice of Agricultural Analysis. Vol. I. *Soils.* By HARVEY W. WILEY, A.M., Ph.D. Second Edition. Easton, Pa.: The Chemical Publishing Company. 1906.

THE alterations which have been introduced into the second edition of this book are of very considerable importance, and it may almost be said to constitute a new work, preserving, however, the characteristic good features of its predecessor. The arrangement is as systematic as before, and all processes of soil analysis are treated in great detail, mechanical analysis in particular being described very fully. The activity of nitrifying organisms in the soil is treated chiefly from a chemical point of view, and sufficiently full references are given to enable those who wish to go deeper into the subject to map out the necessary course of reading. Some parts of the contents of the first volume in the first edition, which relate more to fertilisers than to soils, are now relegated to the second volume, and new matter is introduced to bring the book up to date. The author has been particularly careful to include all methods of historical or scientific interest even if technically they may be regarded as superseded, with the result that it is conceivable that the agricultural chemist using the book might find it difficult to choose amongst so many methods the one best suited for his purpose, although he would, on the other hand, be guided by the full descriptions which are given of the official methods of soil analysis recognised in the United States.

OBITUARY.

DEATH OF M. BERTHELOT.

WE regret to announce the death, at the age of seventy-nine, of probably the most eminent of French men of science, M. Marcelin Berthelot. Virtual founder of the science of thermo-chemistry and one of the most successful pioneers in the great branch of science known as synthetic chemistry, his distinction as a philosopher, as a writer, and as a great citizen contributed to make his name one of the most justly renowned of the Nineteenth Century in France. Of world-wide reputation as a savant, in whom intuition and a critical method seemed ideally balanced for research, he was no mere recluse. The windows of his laboratory were wide open upon the world. No manifestation of the thought of his time was uncongenial to the encyclopædic curiosity of this intimate friend of Renan. The facility of his assimilative faculty recalled indeed that of the great thinkers and men of action of the renaissance who boxed the compass of the knowledge of their time and to whom nothing that concerned human speculation was foreign. Goethe defined the man of genius as he who is fully abreast of his epoch. Judged by this standard, none ever more deserved the name than Marcelin Berthelot. He passed from his laboratory in the College de France to his seat as Senator at the Luxembourg and from a sitting of the French Academy or of the Academy of Medicine to the Ministerial bench at the Chamber always with the same integral mastery of his intelligence, the same philosophically well-classified and ready mind. Once even, as England remembers, he was Minister for Foreign Affairs. His death is more than a national loss. It is a loss for elevated thought and disinterested research all over the world. The mourning will be general.

M. Berthelot died in very dramatic circumstances. His wife had been ill for a year. When he entered her room on the afternoon of Monday last he found her dead. The shock must have overwhelmed him, for he then and there expired.

Marcelin Pierre Eugène Berthelot was the son of a physician, and was born in Paris on October 29, 1827. Educated at the Lycée Henri IV., he had a brilliant career, but though he specially distinguished himself in philosophy, he ultimately devoted his energies to scientific pursuits. At the beginning of 1851 he was appointed *préparateur* to the chemist Balard at the Collège de France, and it was at this period that he formed with Renan, whose humble lodgings were next door to his own, a friendship which only ended with Renan's death. In 1854 he became famous in the chemical world through his doctoral thesis on the combination of glycerin with acids, a continuation of the classical researches of his countryman, Chevreul, on fats. During the nine years which he spent at the Collège de France he was engaged mainly on problems of

synthetic chemistry, and he succeeded in reproducing from their elements a great number of natural bodies—hydrocarbons, alcohols, fats, sugars—as well as in forming many artificial new ones. His results were summed up in "Chimie Organique fondée sur la Synthèse," which was published in 1860, and marks an era in the history of that branch of chemistry. In 1859 he was chosen Professor of Organic Chemistry at the Ecole de Pharmacie, and six years later a Chair of Organic Chemistry was created for him at the Collège de France, which he occupied for the rest of his life. Here he turned to the second branch of study with which his name is specially associated—that of thermochemistry, or the relations between heat and chemical change—and his researches were described in two large volumes, "Mécanique Chimique fondée sur la Thermo-chimie," published in 1879, followed by two more on "Thermo-chimie" in 1897. By a natural extension of these studies he was led to the investigation of explosives from both the theoretical and practical aspects; the former were represented by his book "Sur la Force de la Poudre et des Matières Explosives," published in 1872, and the latter by the services he rendered his country by providing ammunition, devising mines, &c., during the siege of Paris, and later as head of the French Explosives Committee. Later in his life he turned his attention to the history of the science which he so greatly adorned, and his book on "Les Origines de l'Alchimie," together with his publication, with translations and notes, of various old Greek, Arabic, and Syriac treatises on alchemy, shed a flood of light on the chemistry of the Middle Ages. Berthelot, who succeeded Pasteur in 1889 as perpetual secretary of the Academy of Sciences, was Minister of Public Instruction in the Goblet Cabinet in 1886-87, and Minister of Foreign Affairs in the Bourgeois Cabinet in 1895-96. From 1876 he was Inspector-General of Higher Education, and he continued to take a keen interest in educational questions after his election as a life Senator in 1881.—*The Times*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

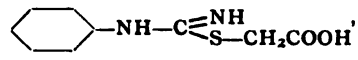
Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 9, March 4, 1907.

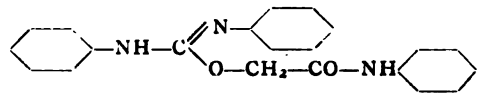
Heats of Combustion and Formation of certain Nitrogenous Bodies of Physiological Value.—M. Berthelot and Ph. Landrieu.—The following results were obtained by combustion with oxygen of specimens of hæmatin, hæmoglobin, and bilirubin:—1. *Hæmatin.*—Fine brilliant crystals, deep violet, losing weight when dried at 115° in a current of dry air. Analysis—C, 64·0; H, 5·1; N, 9·9; Fe, 9·9; O, &c., 11·1. Heat of combustion for 1 grm. substance = 5231 cals. at constant volume, 5236 cals. at constant pressure; the final state being CO_2, H_2O, and magnetic iron oxide, making for 1 grm. C (at constant pressure) 8181 cals. Heat of formation for 1 grm. substance = +1691 cals. 2. *Bilirubin.*—Non-crystalline brown powder. Dried as in the preceding case. Analysis—C, 66·01; H, 6·01; N, 9·03; O, 18·95. Supposed formula, $C_{16}H_{18}N_2O_4$ . . . 302; mean heat of combustion, 6787 at constant volume, 6793 at constant pressure, making, for 1 grm. C, 10,291 cals.; for the formula, 2051·5 cals. Heat of formation for 1 grm., +1505 cals.; for the formula, 454·5 cals. 3. *Hæmoglobin of Horse.*—Brilliant deep red needles. Heat of combustion, 5889 cals. at constant pressure. In 1891 this figure was given as 5914·8 cals., with the analysis—C, 55·48; H, 7·30; N, 17·64; S, 1·11; P, 0·82; O, 17·65. From this the heat of formation is 1091 cals.

Alcoholysis of Castor-oil.—A. Haller.—The author has investigated the bodies resulting from the alcoholysis of castor-oil, when the process is carried out with alcohols containing 1 to 2 per cent of acid. He succeeded in isolating and identifying, in the form of ether-salts of saturated alcohols, the different acids entering into the composition of castor-oil; his results confirm the data furnished by different experimenters upon the presence of glycerides of stearic, ricinoleic, and dihydroxystearic acids. Ænanthylic aldehyde, $C_7H_{14}O$, was prepared by heating ricinoleic ether according to the following equation:—$C_{18}H_{33}O_3R = C_7H_{14}O + C_{11}H_{10}O_2R$.

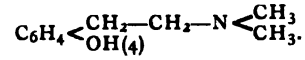
Synthesis of Tertiary Amines: Phenyl-amido-ethane - oxymethane - phenylimine - phenylamine.—Emm. Pozzi-Escot.—This body has been formed as a poly-substituted derivative from the mono-substituted acid, ethanoic-thiomethane-imine-phenylamine,—



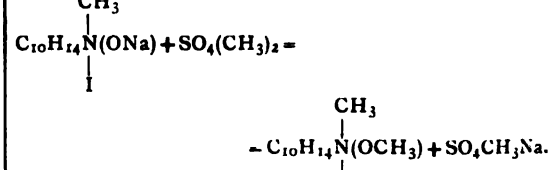
by the action of phenylamine. The resulting compound, consisting of white crystals, fusing at 289°, is represented thus:—



Constitution of Hordenine.—E. Léger.—The formula hitherto ascribed to hordenine is—



The existence of the groups $C_6H_4{<}_{OH}$ and $-N{<}^{CH_3}_{CH_3}$ have been proved beyond dispute, and the object of the present article is to confirm the existence of the chain $-CH_2-CH_2-$ in the para-position to the hydroxyl group. For the experimental proof of this the iodomethylate of methyl hordenine was used. Its formation is given by the following equation:—



One of the decomposition products of this body is the paravinylanisol of hordenine, a heavy liquid hitherto unrecognised. Its identification furnishes the required proof of the presence of the chain $-CH_2-CH_2-$ in the para-position, relatively to the phenol hydroxyl in the molecule of hordenine.

A New Method of Estimating Ammonia in Waters.—Albert Buisson.—The author has previously demonstrated that the estimation of ammonia by the Nessler reagent contains many sources of error, and the method here described, in the first place pointed out by Gerresheim, has now been worked out, and its accuracy verified. Carbonate of soda added to the solution of any salt of ammonia, containing mercuric chloride in the proportion of 5 mols. mercuric chloride to 2 mols. of the ammoniacal salt, causes complete precipitation of the ammonia in the form of a white amorphous compound. This precipitate has been shown to possess a constant composition for slight quantities of ammonia, and has been given the formula $Hg_5N_2Cl_2O + H_2O$, without its having been verified by analysis. It is now found that the simplest formula

possible for this body is $CO_3(Hg_5N_2Cl_2)_2O + 3H_2O$, and the reaction which gives rise to it may be represented thus:—

$$4NH_4Cl + 10HgCl_2 + 10CO_3Na_2 = = CO_3(Hg_5N_2Cl_2)_2O + 20NaCl + 9CO_2 + 8H_2O.$$

By this method, quantities of ammonia greater than 1 mgrm. may be estimated with an accuracy at least equal to that of any methods already known.

Method of Synthesis of the Non-substituted β-Ketonic Nitriles.—Ch. Moureu and I. Lazennec.—The acetylene nitriles, R—C≡C—CN, should, by fixation of water to the acetylene bond, give the β ketonic nitriles, R—CO—CH_2—CN. But the authors' attempts at hydration by means of sulphuric acid did not lead to this result. With phenylpropiolic nitrile, C_6H_5—C≡C—CN, benzoylacetamide, C_6H_5—CO—CH_2—$CONH_2$, was obtained, and amylpropiolic and hexylpropiolic nitriles gave the corresponding acetylene amides, C_6H_{11}—C≡C—$CONH_2$ and C_6H_{13}—C—C≡C—$CONH_2$. On the other hand, hydrolysis of the products of condensation of the acetylene nitriles with the amines was successfully performed, with formation of the initial amine and the corresponding β-ketonic nitrile, *e.g.*,—

$$C_5H_{11}—C(NC_5H_{10})=CH—CN + H_2O =$$

(β-Amyl-β-piperidylacrylic nitrile)

$$= C_5H_{11}—CO—CH_2—CN + NHC_5H_{10};$$

(Caproilacetonitrile. Piperidine.)

and this reaction is best carried out with oxalic acid in ethereal solution. This gives a general method of passing from the acetylene nitriles, R—C≡C—CN, to the corresponding β-ketonic nitriles, R—CO—CH_2—CN. The latter are soluble in the aqueous solution of caustic alkalis or alkaline carbonates, from which they are immediately precipitated by acids. The presence of the group CH_2 between the two electro-negative residues CO and CN evidently accounts for the acid character of these compounds.

MISCELLANEOUS.

The Worshipful Company of Goldsmiths has made a donation of £10,000 to the Lawes Agricultural Trust (Rothamsted Experimental Station), to be devoted to research in connection with the soil, and to be known as the Goldsmiths' Company's Fund for Soil Investigation.

Royal Institution.—A General Monthly Meeting of the Members of the Royal Institution was held on the 4th inst., Sir James Crichton-Browne, M.D., F.R.S., Treasurer and Vice-President, in the Chair. Mrs. Ayrton, Mr. S. G. Brown, Mr. W. Duddell, Mr. Horace Duveen, Mr. W. G. Kirkaldy, Mr. J. E. Mounsey, Mr. W. Peacock, Mr. E. H. Rayner, Mr. E. Swash, and Mr. H. Weguelin were elected Members. The Chairman announced the decease of Professor Henri Moissan, Hon. Mem. R.I., on February 20, and of Mr. L. M. Rate, M.R.I., on February 28, and Resolutions of condolence with the families were passed. The Special Thanks of the Members were returned to "A Member" for a Donation of £60, and to Mr. E. R. Merton for his Donation of £50, to the Fund for the Promotion of Experimental Research at Low Temperatures. The following letter from Mr. W. Burdett-Coutts was read:—

1, Stratton Street, W., February 9th, 1907.

DEAR SIR,—I have the honour to acknowledge the receipt of your letter of the 8th inst. enclosing a Resolution of the Managers of the Royal Institution of Great Britain with reference to the death of the Baroness Burdett-Coutts. I beg you will assure the Managers of my appreciation of the terms of the Resolution, and my gratitude for the expression of their personal sympathy in the great loss I have sustained. I hope I may be permitted to add a few remarks pertinent to the special bearing of the Resolution, and possibly not uninteresting to the Managers and Members of the Royal Institution. I am perhaps the more entitled to such a privilege in dealing with this important tribute to the Baroness's memory, not so much because I am left by her express desire and act in the position of her sole representative, as by reason of my long and close association with a public life which in its inner aspects was otherwise a singularly solitary one. The Baroness's social relationships to Science, her friendships with many, her acquaintance with nearly all, of its eminent professors for the past seventy years, are well known; her efforts to encourage and aid those who were struggling in the same path, not so well: as was her custom. But it probably is not known—at least to this generation—that, without the equipment of a scientific training, she had the keenest personal interest in Science; she delighted to hear its problems discussed, its discoveries explained; and she never failed to follow, with an attention jealous of apathy or interruption, their learned exposition to those around her. I cannot remember the time when the "man of Science," even one little known at the moment or to the company, had not a special place at her table; or the occasion when her own attention, compelling that of others, did not give him full opportunity. The Baroness was a great educationist. At a time before the State assumed that obligation, she naturally devoted her efforts in that respect to the poorest classes. The later phase of the question still found her in the same field, specialising those efforts in directions which the State has only recently begun to follow. But all the while she was mindful of the claims of science, less popular then than now; and in many ways little known, or not remembered, she brought her ever-watchful eye, her discrimination, and her means, to bear on their advancement. If a scholarship was to be established at Oxford, not classics or history, or even theology, but Science claimed her aid. The great Dr. Routh, notoriously difficult of access in his old age, received her at Magdalen as a young girl, bent on the adventure from a party at Nuneham, and became her friend till he died. Yet even that memory, rich in patristic learning, did not avail to place the Bodleian Library as high in her affections as the University Museum. I would venture the opinion that she believed the Pengelley collection of fossils, rightly studied, would have more practical bearing on future human happiness than a gift of old manuscripts. Such things were not done at haphazard. She would spare no trouble to search out both the need and the means. With a touch of characteristic humour she inquired of Sir Wm. Hooker whether Kew Gardens, so far up the Thames, was not poor in Seaweeds. She had already found out the fact, and had secured the Griffiths collection, so rare and extensive that, without impairing the central completeness, it provided duplicates for six other Botanical establishments. She probably had not read Schimper's monograph on the genus Sphagnum, and did not know the details of the muscological collection of Bruch; but she found out that Kew also wanted Mosses, and that Schimper's great herbarium could be acquired. Thus, not so much by wealth as by thoughtful insight, special departments of British Science were enriched at her hands. I could multiply such instances, if time served, in more local spheres; and extend them to branches of science with which the Royal Institution is more directly concerned. It is almost superfluous to say they would touch the careers of many students of Science, young and old, experimentalists, discoverers, halting in their progress for want of the help that came from an unknown hand. It is not my purpose to examine the motives of this marked and consistent attitude of the Baroness towards Science; rather to suggest, as I believe, that it was in the first place natural, and without motive, satisfying the instincts of a mind peculiarly analytical, suggestive, and acute. But she was also deep-thinking and far-seeing; while she

worked at the daily round, she was looking always to the horizon. She knew the constant and munificent aids that Science had brought, and must continue to bring, to the great human problem to which she devoted her life. And it was inherent in her nature, in days gone by, when Science appealed to a more limited and less generous circle than now, to select it, simply on that account, for such encouragement as her means and position, her personal sympathy and interest, could often afford. I have felt it a grateful duty, to the Baroness's memory, and to the honour paid it by the Royal Institution, to trespass on the Managers' attention at this length, for which I hope the reasons apparent will be adequate excuse.—I am, dear Sir, yours faithfully,

(Signed) W. BURDETT COUTTS.

Sir William Crookes, F.R.S.,
Honorary Secretary, Royal Institution.

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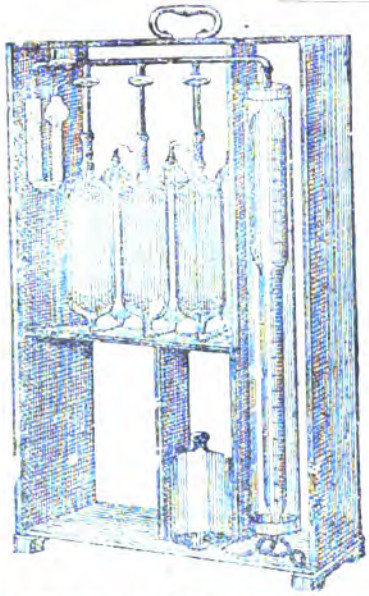

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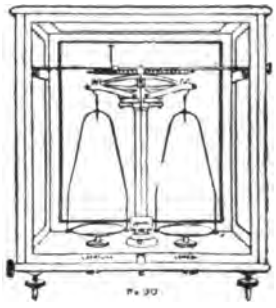

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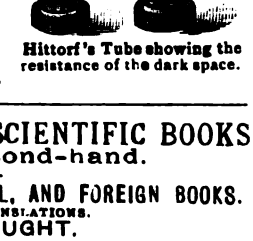

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THE THERMAL BEHAVIOUR OF PHOSPHORUS IN ITS COMPOUNDS.

By J. CLARK THOMLINSON, B.Sc.

In dealing with this subject we have hitherto found hydrogen to show a remarkable uniformity of behaviour, the value 7·470 cals. enabling us to show consistent results in demonstrating the existence of thermo-chemical equivalence.

This value can be applied equally satisfactorily in a similar method of treatment of the element phosphorus, in its thermo-chemical relations, for, taking as our starting point gaseous hydrochloric acid, we have the following reaction:—

$$H + Cl = HCl + 22{\cdot}000 \text{ cals.},$$

from which the thermo-chemical equivalent of chlorine would be 22·000 - 7·470 cals. = 14·530 cals.

Although we here bring into notice an element whose thermal value like that of phosphorus we are about to demonstrate, the line of reasoning we are pursuing will be found to confirm such views as we arrive at.

The heats of formation of the tri- and pentachlorides of phosphorus are given in the following equations, from which with the above value for chlorine—

$$P + Cl_3 = PCl_3 + 75{\cdot}300, \quad P + Cl_5 = PCl_5 + 104{\cdot}990 \text{ cals.}$$

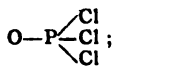
we obtain for the element phosphorus as a trivalent element $P\equiv$ = 31·710 cals., and when pentavalent $P\overset{\equiv}{\equiv}$ = 32·340 cals.

For the further treatment of the subject we must recur to the value assigned to oxygen in thermo-chemical reactions.

As a divalent element the value 52·545 cals. for oxygen is applicable to many compounds in which it occurs, and the quadrivalency and pentavalency of oxygen, we found, could be assigned thermal values from a consideration of the heats of formation of hydrogen peroxide and ozone in relation to ordinary oxygen and to the oxides of nitrogen.

Such values for oxygen would be $O\equiv$ = 15·180 cals. and $O\overset{\equiv}{\equiv}$ = −3·503 cals. By a simple process of addition which leads us to say that a decrease of two bonds in the valency of oxygen corresponds to an increase of 37·365 cals. in the amount of heat evolved by a grm.-atom of oxygen entering into chemical combination, so we may say that the decrease of one further in the valency of oxygen would correspond to an increase, 18·683 cals., or the thermo-chemical equivalent of oxygen where it exerts only one bond of union in the molecule consistent with its behaviour when di-, quadri-, or pentavalent would be O— = 71·228 cals.

That such a value is consistent with experience may be shown by writing the structural formula for phosphoryl chloride—



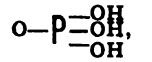
where phosphorus is represented as quadrivalent and oxygen presents a univalent character, as described above.

Such a compound, representing phosphorus as quadrivalent, would give to this element an equivalence the mean of 31·710 and 32·340 cals., where the difference is so slight that we can neglect the altered valency of phosphorus in phosphoryl chloride,—

$$PCl_3 + O = POCl_3 + 70{\cdot}660 \text{ cals.}$$

In the above reaction there should be theoretically an evolution of heat equal to 71·228 cals., the agreement of these values confirming the values arrived at above.

The similarity of constitution and association of the acids and acid chlorides of phosphorus at once leads to the following constitutional formula for phosphoric acid:—

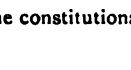
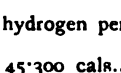


which, by calculation, would have the heat of formation 283·298 cals., the actual value being 300·080 cals.

Similarly, the experimental and calculated values for other oxides and acids of phosphorus are—

	Experimental value.	Calculated value.
Phosphoric anhydride, P_2O_5 ..	369·900 cals.	327·405 cals.
Phosphorous acid, H_3PO_3 . ..	224·630 „	211·755 „
Hypophosphorous acid, H_3PO_2	137·666 „	159·210 „

In introducing chlorine into the above consideration of the thermochemical equivalent of phosphorus we may also refer to a confirmation of the agreement between theory and experiment as shown in sulphur chloride, S_2Cl_2, and sulphonyl chloride, SO_2Cl_2 (see CHEMICAL NEWS, xciv., p. 152).

With the constitutional formula  sulphur chloride resembles hydrogen peroxide,  , which has a heat of formation 45·300 cals., the second oxygen atom entering the molecule with an absorption of 23·060 cals., or one-half that given out by a divalent atom when united with both valencies to a monovalent element.

Similarly, divalent sulphur, S= = −9·418 cals., and, as above shown, Cl = 14·530 cals., so that we might expect the heat of formation of sulphur chloride to be represented as the sum of the equivalents of $S + Cl^2$ and half the heat of formation of a single sulphur atom, this representing the entrance of the second sulphur atom into the molecule, which numerically gives the heat of formation of this compound as 14·933 cals., the experimental value being 14·260 cals.

In the same way sulphonyl chloride, $O\overset{\equiv}{\underset{\equiv}{}}S = Cl_2$, gives a calculated heat of formation equal to 87·948 cals., and experiment 89·780 cals.

METHODS FOR THE DETERMINATION OF CREATININ AND CREATIN IN MEATS AND THEIR PRODUCTS.

By H. S. GRINDLEY and H. S. WOODS.

In previous papers from the Chemical Laboratory of the University of Illinois, it has been conclusively proven by improved methods of analysis that meats contain a considerably greater quantity of so-called organic extractives than previous investigations had shown. (See *Journ. Am. Chem. Soc.*, 1904, xxvi., 1086; 1905, xxvii., 658; 1906, xxviii., 25 and 469). It has also been demonstrated that a considerable portion of flesh is soluble in cold water; that the cold water extraction of meat can be made complete, and that it is possible to determine with accuracy the total nitrogenous organic extractives of such extracts. In connection with the researches of this laboratory upon the chemistry of flesh, it became desirable to devise means to ascertain the relative proportion of the different components which go to make up these extractives. The creatin and also the creatinin if present in meats would undoubtedly be completely extracted by cold water. That being true, an attempt was made to apply the colorimetric

method of Folin to the estimation of the creatinin and creatin, using the Duboscq colorimeter (*Zeit. Physiol. Chem.*, 1904, xli., 223; *Am. Journ. Physiol.*, 1905, xiii., 48).

Tests for Creatinin in Meats.

In the first place the method was used to test for creatinin in a cold water extract of chicken flesh. 200 cc. portions of the extract, representing 4·112 grms. of fresh chicken flesh, were tested directly for creatinin in the manner described by Folin in estimating this constituent in urines. The tests gave only the slightest indications, if any, of the presence of creatinin. When the alkaline picrate solution of the extract of the chicken flesh was allowed to stand for a few days it turned red, the colour growing more intense each day. Water extracts of beef and solutions of meat extracts when treated directly with the alkaline picrate solution behaved in a similar manner, showing that creatin under these conditions is gradually converted into creatinin even in alkaline solutions. This is contrary to the supposed behaviour of these two nitrogenous bodies in the presence of alkaline solutions. The true nature of this reaction is now being further studied in this laboratory.

In order to prove further the presence or absence of creatinin in aqueous extracts of fresh flesh, 400 cc. of a cold water extract of beef, representing all of the soluble constituents from 8 grms. of lean beef round, were tested directly for creatinin as above by Folin's method. The tests gave no trace of creatinin. The alkaline picrate solutions of these beef extracts upon standing for a few hours gradually turned red, as did the extracts from chicken flesh. These experiments, which have often been repeated, demonstrate that the work and conclusions of Toppelius and Pommerehne (*Arch. de Pharm.*, 1896, ccxxxiv., 380), and later that of Emil Wörner (*Zeit. Physiol. Chem.*, 1899, xxvii., 1), were correct, and that the investigations of G. S. Johnson (*Proc. Roy. Soc.*, 1901, l., 287), which led him to the deductions that perfectly fresh meats contain creatinin, but no creatin, were wrong. As judged by Jaffe's reaction fresh meats contain only the slightest trace of creatinin if any at all. However, the creatin of flesh is, in part at least, very readily changed to creatinin. The following experiment demonstrates this fact:—Three 500 cc. portions of a cold water extract, each representing 10·015 grms. of chicken flesh, were carefully evaporated upon a water-bath to a volume of 50 cc. in order to completely coagulate the soluble proteid matter. The solutions were filtered, the precipitates thoroughly washed, and the filtrates evaporated to a volume of 75 cc. They were then tested for creatinin and they gave readings which represented 0·08, 0·11, and 0·15 per cent of creatin, calculated upon the basis of the fresh substance of the flesh. This experiment and a number of others which we have made prove that the evaporation of an aqueous extract of flesh upon the water-bath, in the presence of its natural acidity, changes creatin to creatinin. It is just possible that this action may be one influence which produces flavour during the cooking of meats. This subject is now being studied in connection with these researches.

Estimation of Creatin in Meats.

The estimation of creatin in the aqueous extracts of flesh were made by taking 500 cc. portions of the solution, evaporating and filtering as mentioned above to remove the coagulable proteids. The solutions thus obtained were treated with hydrochloric acid and evaporated upon the water-bath to a small volume. This treatment was repeated with the addition of water until all the creatin had been changed to creatinin. The solutions were then made up to exactly 100 cc. and 30, 40, and 50 cc. of the same were used to make the quantitative test with the colorimeter.

Table I. gives a few determinations of creatin in different kinds of flesh.

As a result of the preliminary experiments here reported, the following method is recommended for the estimation of creatin in flesh. Prepare the aqueous extract of the flesh as described in a former paper from this laboratory (*Journ. Am. Chem. Soc.*, 1905, xxvii., 658):—

Evaporate 500 cc. portions of the extracts to 50 cc., filter, wash the coagulated proteid thoroughly with hot water, add 25 cc. of N/10 hydrochloric acid, to each of the filtrates, and evaporate them to a volume of 10 to 15 cc. Now add 50 cc. of water and 10 cc. of N/10 hydrochloric acid and again evaporate to a volume of 10 to 15 cc. Care must be taken to insure the complete change of creatin to creatinin. Cool the solutions, transfer them to a 100 cc. measuring flask, and dilute to the mark. Transfer an aliquot portion of this latter solution, equivalent to 200 cc. of the original extract, to a 500 cc. flask, add 15 cc. of a 1·2 per cent (saturated) picric acid solution and 5 cc. of a 10 per cent sodium hydroxide solution, shake well, and allow the solution to stand for five minutes. In the meantime practice reading the colorimeter, using an N/2 solution of potassium bichromate in each cylinder. Now dilute the alkaline creatinin picrate solution to 500 cc., mix thoroughly, rinse one of the cylinders well with this unknown solution, add a portion of the solution to the cylinder, and make several careful readings at once, comparing the unknown solution with 8·0 mm. of the bichromate solution. According to Folin, the correct reading in millimetres divided into 81 gives the number of milligrms. of creatinin present. This figure multiplied by 1·16 gives the number of milligrms. of creatin. If an aliquot portion equivalent to 200 cc. of the extract does not give a satisfactory reading, use such a portion as will give a reading of about 8 mm.

This method has been used successfully for the determination of creatinin and creatin in uncooked and cooked meats and in meat broths and meat drippings.

Creatinin and Creatin of Commercial Beef Extracts.

(Note.—After the data herein recorded had been obtained, and this paper had been written, the number of the *Journal of the American Chemical Society* for October, 1906, was received containing the paper of Bigelow and Cook upon "The Separation of Proteoses and Peptones from the simpler Amino-bodies." In this paper the authors mention the fact that they have applied the method of Folin for the determination of creatin in meat extracts, but they give no analytical results. Notwithstanding this preliminary notice of Bigelow and Cook, it was deemed advisable to publish our paper in full and without any modifications, since it gives data which prove without doubt that the method of Folin may be applied successfully to the estimation of creatinin and creatin in meats, in meat broths, in meat extracts, and in other meat products. We have been using this method continuously in our investigations upon the chemistry of flesh since March 15, 1906).

The nature of a considerable proportion of the constituents of commercial beef extracts is still unknown. A ready method for the estimation of creatinin and creatin in these products would undoubtedly be useful in determining the commercial value and the grade of the various commercial beef extracts and similar preparations which are now upon the market. As Folin's method for the estimation of these substances in urines proved to be an excellent means for the determination of these nitrogenous constituents which are contained in aqueous extracts of flesh, we undertook to apply it to the determination of these bodies in commercial extracts. The method has proved equally successful in this connection. Its application here has demonstrated that commercial beef extracts contain both creatinin and creatin. The details of the procedure in the case of the extracts are entirely similar to those outlined above for cold water extracts of flesh. The results of a number of determinations of creatinin and creatin in a number of the prominent commercial extracts now on the market are given in Tables II., III., and IV.

These results show that there are marked differences in commercial meat extracts as to their content of creatinin

TABLE I.—*Creatin in Fresh Flesh.*

No. of sample.	Kind of meat.	Weight of sample.	Reading of colorimeter.	Weight of creatinin due to creatin (A).	Weight of creatin (A × 1·16).	Creatin.
		Grms.	Mm.	Mgrms.	Mgrms.	Per cent.
2075	Beef round	2·8066	8·2	9·88	11·46	0·41
2084	Cold storage fish.. ..	3·8369	7·9	10·25	11·89	0·31
2085	„ „	4·6625	7·8	10·38	12·04	0·26
2110	Refrigerated chicken ..	4·0084	8·1	10·00	11·60	0·29
2111	„ „ ..	4·9152	8·4	9·64	11·18	0·23
2112	„ „ ..	5·0262	7·8	10·38	12·04	0·24

TABLE II.—*Creatinin in Commercial Beef Extracts.*

No. of sample.	Weight of sample.	Reading of colorimeter.	Weight of creatinin.	Per cent of creatinin.
	Grm.	Mm.	Mgrms.	
1.	0·3008	7·8	10·38	3·45
2.	0·2545	8·6	9·42	3·70
3.	0·5800	8·1	10·00	1·72
4.	0·7221	8·0	10·13	1·40
5.	0·1972	7·8	10·38	5·27
6.	0·7234	8·2	9·88	1·37
7.	0·8206	8·2	9·88	1·20
8.	0·5458	7·7	10·52	1·93
9.	1·1391	8·6	9·42	0·83
10.	0·4720	8·1	10·00	2·12
11.	0·6786	8·5	9·47	1·39
12.	0·7540	7·5	10·08	1·30
13.	0·2774	7·3	11·10	4·00

TABLE III.—*Creatin in Commercial Beef Extracts.*

No. of sample.	Weight of sample.	Reading of colorimeter.	Weight of original creatinin *plus* creatinin due to creatin.	Weight of original creatinin (see Table I.).	Weight of creatinin due to creatin (A).	Weight of creatin (A × 1·16).	Creatin.
	Grm.	Mm.	Mgrms.	Mgrms.	Mgrms.	Mgrms.	Per cent.
2.	0·1833	7·9	10·25	6·78	3·47	4·03	2·18
3.	0·2636	7·7	10·52	4·55	5·97	6·93	2·63
4.	0·1850	7·9	10·25	2·60	7·65	8·74	4·79
5.	0·1512	8·4	9·64	7·96	1·68	1·95	1·29
6.	0·1841	8·6	9·42	2·38	7·04	8·17	4·35
7.	0·1641	8·0	10·13	1·98	8·15	9·45	1·20
8.	0·2593	8·0	10·13	5·00	5·13	5·95	2·29
9.	0·7088	8·8	9·20	5·86	3·34	3·87	0·55
11.	0·3016	5·0	16·20	4·19	12·01	13·93	4·62
12.	0·2262	6·85	11·82	2·94	8·88	10·30	4·55
13.	0·2080	7 00	11·57	8 32	3·25	3·77	1·81

TABLE IV.—*Combined Creatinin and Creatin in Commercial Beef Extracts.*

No. of sample.	Creatinin.	Creatin.	Sum of creatinin and creatin
	Per cent.	Per cent.	Per cent.
2.	3·70	2·18	5·88
3.	1·72	2·63	4·35
4.	1·40	4·79	6·19
5.	5·27	1·29	6·56
6.	1·37	4·35	5·72
7.	1·20	1·20	2·40
8.	1·93	2·29	4·22
9.	0·83	0·55	1·38
11.	1·39	4·62	6·01
12.	1·30	4·55	5·85
13.	4·00	1·81	5·81

and creatin. In some of the extracts creatinin occurs in considerably greater quantities than does creatin, while in others the amounts of the latter constituent are greater than the amounts of the former. It is difficult to state at present the cause or causes which, in the preparation or keeping of the commercial extracts, produce this variation in the proportion of these two nitrogenous constituents. Experiments upon meat extracts prepared upon a small scale in the laboratory, from fresh meat, are now under way to find out if possible the conditions which produce the above difference in the relative proportion of creatinin and creatin.

The data here given also show that there is a marked difference in the total amount of creatinin and creatin contained in different commercial extracts now upon the market. Further study will probably show that this difference in the combined amount of these nitrogenous constituents is due, in the main, to the material from which they are manufactured. We hope to be able to study this phase of the work in the near future.

We wish here to express our thanks to Mr. H. H. Mitchell for his valuable assistance in connection with the analytical work involved in this paper. — *Journal of Biological Chemistry*, ii., No. 4.

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 138).

Procedures and Notes (continued).

Procedure 8.—If the use of HF (P. 5) is impracticable, transfer the residue insoluble in acids (P. 2 or 4), with the filter if necessary, to a porcelain crucible, heat until the residue is dry or until the filter is destroyed, mix the residue, which must be very finely divided, with ten to twenty times its weight of a mixture of anhydrous Na_2CO_3 and K_2CO_3, cover the crucible, heat strongly over a powerful burner or over a blast lamp so that complete fusion takes place, and continue the heating for 10—30 minutes. If dark particles of undecomposed substance can still be seen, add gradually in small portions 0·1—0·5 grm. of solid KNO_3, and heat strongly for several minutes. Cool, boil the crucible and its contents with water until the fused mass is disintegrated, filter, and wash the residue thoroughly. Warm the residue with HNO_3 (1·20) until action ceases, and filter out any still undecomposed substance (see N. 2 below). Mix a small part of the HNO_3 solution with a small part of the Na_2CO_3 solution, making the mixture strongly acid with HNO_3, if it is not already so.

If no precipitate forms, mix the remainder of the acid solution with about half the Na_2CO_3 solution, reserving the rest of the Na_2CO_3 solution for the tests for acid radicals. Add about 5 cc. HCl (1·12) (or more if the solution is still alkaline), and filter. (Precipitate, test for silver and lead, P. 12). Evaporate the solution to dryness, moisten the residue with HCl, and again evaporate to decompose nitrates. Heat the residue until it is thoroughly dry at 120—130° in a hot closet or by keeping it in motion over a small flame. Add from a graduate 4 cc. HCl (1·12) and about 20 cc. water; heat to boiling, filter, reject the residue, and dilute the filtrate to 40 cc. (Filtrate P. 21).

If a precipitate forms on mixing small portions of the HNO_3 solution and the Na_2CO_3 solution, treat these solutions separately as described in the preceding paragraph, uniting the precipitates formed by the same group reagent in the subsequent analysis.

Notes.

1. Upon fusion with Na_2CO_3 most compounds undergo metathesis, the acid radical of the compound combining with the sodium, and the metallic element with the carbonate radical. The carbonate formed is, however, sometimes decomposed by heat with production of the oxide or of the metal itself. Acid-forming oxides, such as SiO_2, As_2O_5, and less rapidly Al_2O_3, expel CO_2 from the Na_2CO_3 and form sodium salts. Such reactions are illustrated by the following equations:—

$$BaSO_4 + Na_2CO_3 = Na_2SO_4 + BaCO_3.$$
$$Fe_2SiO_5 + Na_2CO_3 = Na_2SiO_3 + Fe_2O_3 + CO_2.$$
$$4AgCl + 2Na_2CO_3 = 4NaCl + 4Ag + 2CO_2 + O_2.$$
$$SiO_2 + Na_2CO_3 = Na_2SiO_3 + CO_2.$$

After the treatment with water, the acid radical of the substance is therefore found with the excess of Na_2CO_3 in the aqueous extract, while the metallic component remains undissolved by the water and passes into the acid solution.

2. Some substances which are not much acted upon by Na_2CO_3 alone are readily attacked when an oxidising flux like KNO_3 is present. Thus sulphides are converted into sulphates and chromium compounds (such as chromite, $FeO.Cr_2O_3$) into chromates. A few substances, however, such as the oxides of tin, aluminium, and titanium, may be only partially decomposed even by long-continued fusion with the mixed fluxes. An undecomposed residue is best fused with KOH in a nickel or silver crucible and the fusion treated, as described in P. 7, N. 3, first with water and then with HCl.

3. The porcelain crucible is so attacked by the flux that it cannot well be used for a second fusion. Aluminium, calcium, and silica are taken up by the flux, so that these elements, as well as the alkali elements, cannot be tested for later in the analysis. In case all reducible metallic elements and sulphides are known to be absent (see P. 7, N. 1), it is therefore better to make the fusion in a platinum crucible, since then no foreign substances are introduced from the crucible. If platinum is not available, or if it is not known that reducible elements are absent, a pure nickel crucible can be used with advantage in place of the porcelain one. This enables aluminium, calcium, and silica to be tested for; some nickel, but only a few mgrms., will then be found in the acid solution of the fusion. Reducible elements, if present, would alloy with the nickel, but the destruction of a crucible of this cheap material is not of much consequence. Ordinarily a nickel crucible can be used repeatedly.

4. The first and third reactions given in N. 1 are examples of cases where the aqueous and acid solutions must not be mixed, for upon mixing $BaSO_4$ or AgCl would again be formed.

5. Of the metallic elements that may be present, all or a part of the arsenic, antimony, tin, molybdenum, tungsten, aluminium, chromium, and manganese are contained in the Na_2CO_3 solution; and this solution must therefore be analysed for metallic elements. Since this solution may also contain Na_2SiO_3, the solution after the addition of HCl is evaporated to dryness, and the residue is heated at 120—130°; this treatment partially dehydrates the silicic acid and renders it insoluble in HCl. The residue insoluble in HCl after this treatment usually consists only of silicic acid (or tungstic acid). To prove whether it consists wholly of silica, it may be treated with H_2SO_4 and HF as described in P. 5. *To test for tungsten it may be treated with HCl and zinc as described in *P. 6*a*.

6. The residue left after the extraction with water is treated with HNO_3 rather than with HCl, so as to dissolve reduced metals and to prevent the formation of AgCl and $PbCl_2$ at this point.

Confirmatory Experiments and References.

P. 2, N. 1: *Destruction of Organic Matter.*—3 grms. white flour, 1·5 grms. glycerin, 0·5 grm. paraffin, and some filter-paper were treated in separate experiments, according to the procedure: nearly all the organic matter was decomposed by the first two or three treatments with H_2SO_4 and HNO_3, and after a few more treatments colourless solutions were obtained.

P. 2, N. 2.—See C. E., P. 5, N. 4 and 5.

P. 3, N. 7: *Oxidation of Mercurous Salts by* HNO_3.—100 mgrms. Hg as $Hg_2(NO_3)_2$ were boiled with a little HNO_3 (1·42) for one minute, the solution was diluted, and HCl added; no precipitate was formed, thus showing that the mercurous salts had been completely oxidised. 100 mgrms. Hg as $Hg_2(NO_3)_2$ were boiled for ten minutes with 25 cc. HNO_3 (1·04), and HCl was added: a large precipitate of Hg_2Cl_2 resulted, showing that dilute HNO_3 does not oxidise a mercurous salt rapidly.

Volatility of Mercury and Arsenic Compounds.—Separate solutions containing 1 mgrm. Hg as $HgCl_2$ in HNO_3, HCl, *aqua regia*, and H_2SO_4 were carefully evaporated just to dryness; the residue was in each case dissolved in a little water, and the solution saturated with H_2S; a precipitate of HgS estimated by comparison at not less than $\frac{2}{3}$ mgrm. Hg was obtained in each case, showing that not much of the mercury had been volatilised. It was found that $HgCl_2$ was not converted into $Hg(NO_3)_2$ by the evaporation with HNO_3.

1 mgrm. Hg as $HgCl_2$ was heated in a hot closet at 125°, the casserole was washed out with water, and the solution

* From the *Technology Quarterly*, xix., No. 3 September, 1906.

saturated with H_2S: no precipitate was obtained, thus showing that the $HgCl_2$ was completely volatilised.

1 mgrm. Hg as $Hg(NO_3)_2$ was heated for two days at 125° in a hot closet, dissolved in water, and treated with H_2S: an HgS precipitate resulted, whose size indicated that little or none had volatilised.

10 mgrms. As as As_2O_3 were added to 10 cc. HCl (1·20), and the solution was boiled vigorously for about 15 seconds; the solution was somewhat diluted and then saturated with H_2S: only 1—2 mgrms. As as As_2S_3 were precipitated.

The experiment was repeated, except that the HCl solution was evaporated to 2 cc.: scarcely any precipitate of As_2S_3 was obtained. In another experiment the solution was evaporated to dryness: no precipitate of As_2S_3 formed.

A solution of 10 mgrms. As as As_2O_3 in 10 cc. H_2O and 2 cc. HCl (1·20) was boiled for 30 seconds and H_2S was passed in: a precipitate appearing like that given directly by 10 mgrms. As was obtained, showing that very little if any arsenic was volatilised. A similar solution of 10 mgrms. As was evaporated to 2 cc.; it gave with H_2S a precipitate estimated to contain 3 mgrms. As.

1 and 10 mgrms. As as As_2O_3 dissolved in 5—10 cc. HCl (1·20) were boiled in covered casseroles, oxidised with bromine water, evaporated to dryness, and dissolved in HCl; the solution was then precipitated with H_2S: the amount of arsenic precipitated was estimated to be nearly as great as that originally taken, thus showing that arsenic in the higher state of oxidation is not volatilised.

P. 3, N. 9—12: *Solubility of the Dehydrated Hydroxides in* HNO_3.—For this and for a statement as to other substances that the residue may contain, see A. A. Noyes, *Technology Quarterly*, 1903, xvi., p. 121; also Chemical News, xciii., p. 171.

P. 4, N. 1: *Solubility of* $PbSO_4$, $BaSO_4$, AgCl, *and* $Sn(PO_4)_4$ *in* HCl.—See *Ibid.*, 1903, xvi., p. 126.

Action of HCl *and* HNO_3 *on* AgCN *and* AgI.—50 mgrms. Ag as freshly precipitated AgCN were boiled with 20—30 cc. HCl (1·20): the precipitate dissolved quickly.

To 50 mgrms. Ag as freshly precipitated AgI were added 10 cc. HNO_3 (1·42), and the mixture was evaporated, diluted, filtered, and HCl was added to the filtrate: a precipitate of AgCl estimated to contain 15 mgrms. Ag was obtained, showing that AgI is slowly decomposed by HNO_3. The experiment was repeated with 50 mgrms. Ag as AgCN: no precipitate of AgCl was obtained.

P. 4, N. 4: *Solubility of Metastannic and Antimonic Acids in* H_2SO_4 *and* HCl.—200 and 400 mgrms. Sn as metastannic acid, which had been heated for one hour in a hot closet at 120°, were treated in separate experiments with 3 cc. concentrated H_2SO_4 as described in the Note: in the first case all the tin, in the second all but a few mgrms. of it, dissolved on boiling the acid for about a minute. The solutions were diluted with 2—3 cc. water and boiled: no precipitate formed. The first solution was cooled and poured into 10 cc. cold water: a solution which remained clear for several hours was obtained, from which a white precipitate separated at once on boiling. To the other solution (containing 400 mgrms. Sn) were added 5 cc. HCl (1·12) and 50 cc. water; no precipitate appeared, even on boiling. The solution was diluted to 200 cc.: a white precipitate then formed, The precipitates obtained from these solutions dissolved readily in dilute HCl and in concentrated H_2SO_4.

200 mgrms. Sb as hydrated Sb_2O_5, previously heated at 120°, were boiled with 5 cc. HCl (1·12) for two or three minutes: complete solution resulted.

200 mgrms. Sb as hydrated Sb_2O_5 did not dissolve in 3 cc. boiling concentrated H_2SO_4 or on dilution, but dissolved readily when HCl was added as described in the Note. This solution was diluted with 10 cc. water: a slight precipitate formed, which dissolved on the addition of a little HCl and warming.

In another experiment 200 mgrms. Sn as dehydrated metastannic acid were boiled for about 30 minutes with HCl (1·20): at the end of that time the solid had dissolved nearly, but not quite completely.

(To be continued).

PHOSPHORIC ACID, POTASH, NITROGEN, SOILS, ASH, AND INSECTICIDES.*

Report of Committee A on Recommendations of Referees.—(R. J. Davidson, *Chairman*).

1. Nitrogen.

It is recommended—

1. That the work on the Fuller modification of the official Gunning method be discontinued, and that the Gunning method remain as it is now stated.

Adopted.

(The Fuller modification consists in the addition of 0·5 to 0·75 grm. of copper sulphate after digesting with sulphuric acid and potassium sulphate for one-half hour).

2. (*a*) That the work on the neutral permanganate method be continued along the same lines as this year, having in mind the influence of excessive amounts of non-nitrogenous material in the source of nitrogen. (*b*) That work be directed along the line of eliminating some of the many details of the method which influence to too great a degree the results obtained.

Adopted.

3. That the work on the alkaline permanganate method be continued, and that the quantity of material taken be changed to 0·0675 grm. nitrogen; that the quantity of alkaline permanganate used in digestion be changed to 150 cc., and that 100 cc. be distilled off before titration. The modified method should read:—

Weigh out an amount of sample containing 0·0675 grm. of nitrogen and transfer to a 600 cc. distilling flask. After connecting with condenser to which the receiver containing the standard acid has been attached, digest with 150 cc. of alkaline permanganate solution (16 grms. of pure potassium permanganate and 150 grms. of sodium hydrate dissolved in water, and made to 1000 cc.) for thirty minutes below the boiling-point. Then boil until 100 cc. of distillate is obtained. If the material shows a tendency to adhere to the sides of the flask an occasional gentle rotation is necessary during distillation.

Referred to the Referee for 1907 for investigation as to whether this method, or some modification of it, can be applied to all organic nitrogenous materials, especially cotton-seed meal.

4. That the method for standardising hydrochloric acid proposed in 1905, and referred to the Referee for 1906, be adopted, and that the method now given in the official methods be dropped. (See *Bull.* 46, Rev., p. 14, under "4—Determination of Nitrogen"). The proposed method reads as follows:—

By means of a preliminary test with silver nitrate solution, to be measured from a burette, with excess of calcium carbonate to neutralise free acid and potassium chromate as indicator, determine exactly the amount of nitrate required to precipitate all the hydrochloric acid. To a measured and also weighed portion of the standard acid add from a burette one drop more of silver-nitrate solution than is required to precipitate the hydrochloric acid. Heat to boiling, cover from the light, and allow to stand until the precipitate is granular. Then wash with hot water through a Gooch crucible, testing the filtrate to prove excess of silver nitrate. Dry the silver chloride at 140° to 150° C.

Adopted as the official method.

* Extracts from the Proceedings of the American Association o Official Agricultural Chemists, 1906.

[*Note by the Secretary.*—The following method for the estimation of nitrogen was submitted by Mr. T. S. Gladding, together with comparative results on 81 samples obtained by the three methods compared, the question being raised as to whether a combination of two official methods, the Gunning and the Kjeldahl, would be considered an official method. Mr. Gladding requested that appropriate action be taken, and the method is submitted for the information of the Referee without instructions from the Association :—

Combination Method : Kjeldahl and Gunning Methods.

One grm. of fertiliser, 25 cc. of sulphuric acid, 10 grms. of potassium sulphate, 0·7 grm. of mercuric oxide ; heat till water white. Cool, add 200 cc. of water, 0·5 grm. of zinc-dust, 25 cc. of potassium sulphide solution, 50 cc. of soda solution, and distil].

2. SEPARATION OF NITROGENOUS BODIES.

A. *Milk and Cheese Proteids.*

It is recommended—

1. That the original method of preparing the water extract (cheese analysis), proposed by Van Slyke and Hart, be so altered as to call for the use of 1000 cc. of water in place of 500 cc. (Proceedings, 1902, *Bull.* 73, p. 89).

Adopted.

2. That the method of drawing the water extract through a thick pad of asbestos, after it has been separated from the fat and insoluble nitrogenous matter by cotton-wool, be further studied.

Adopted.

3. That the temperature at which the extraction is made be further studied.

Adopted.

4. That the completeness of the extraction of matter soluble in salt solution be further studied.

Adopted.

B. *Vegetable Proteids.*

The report of the Referee was received too late for action to be taken by Committee A, but the following recommendation is submitted as a matter of record :—

It is recommended for the purpose of securing greater uniformity of results, that in the extraction of alcohol-soluble nitrogen in wheat and flour 70 per cent alcohol by weight, sp. gr. 0·871, be used.

C. *Meat Proteids.*

It is recommended—

1. That the modified tannin salt method as described in the Proceedings of the Association for 1905 (Bureau of Chemistry, *Bulletin* No. 99, p. 182) be adopted as a provisional method.

Referred again to the Referee for recommendation in 1907.

2. That the xanthin base method of Schittenhelm (Proceedings, 1904, *Chemistry Bull.* No. 90, p. 129) be adopted as a provisional method.

Referred again to the Referee for recommendation in 1907.

3. That the application of the creatinin method as applied by Folin to the urine be further studied by the Association (*Zeit. Phys. Chem.*, 1886, x., 391).

Adopted.

3. INORGANIC PLANT CONSTITUENTS.

It is recommended—

That the peroxide method for total sulphur be adopted as official.

(This method was recommended as provisional by the Referee in 1905, *Bull.* No. 99, p. 133, the following restatement of the method varying only in technique) :—

Peroxide Method for Sulphur in Plants.

Place from 1·5 to 2·5 grms. of material in a nickel crucible of about 100 cc. capacity, and moisten with approximately 2 cc. of water. Mix thoroughly, using a nickel or platinum rod. Add 5 grms. of pure anhydrous sodium carbonate, and mix. Add pure sodium peroxide, small amounts (approximately 0·50 grm.) at a time, thoroughly mixing the charge after each addition. Continue adding the peroxide until the mixture becomes nearly dry and quite granular, requiring usually about 5 grms. of peroxide. Place the crucible over a low alcohol flame (or other flame free from sulphur), and carefully heat with occasional stirring until contents are fused. (Should the material ignite, the determination is worthless). After fusion remove the crucible, allow to cool somewhat, and cover the hardened mass with peroxide to a depth of about 0·5 cm. Heat gradually, and finally with full flame until complete fusion takes place, rotating the crucible from time to time in order to bring any particles adhering to the sides into contact with the oxidising material. Allow to remain over the lamp for ten minutes after fusion is complete. Cool somewhat. Place warm crucible and contents in a 600 cc. beaker, and carefully add about 100 cc. of water. After violent action has ceased, wash material out of crucible, make slightly acid with hydrochloric acid (adding small portions at a time), transfer to a 500 cc. flask, cool, and make to volume. Filter, and take a 200 cc. aliquot for determination of sulphates by precipitating with barium chloride in the usual manner.

Referred to Referee for 1907 for recommendation as to final action.

2. That the combustion method (*i.e.*, the Sauer-Tollens-Barlow method) for determining volatile inorganic plant constituents be further investigated (Sauer, *Zeit. Anal. Chem.*, 1873, xii., 32 ; Barlow-Tollens, *Journ. Am. Chem. Soc.*, 1904, xxvi., 341).

4. POTASH.

It is recommended—

1. That the study of the volumetric method for use in both soil and fertiliser analysis be continued. (Proceedings, 1905, Bureau of Chemistry, *Bull.* No. 99, p. 135).

Adopted.

2. The following recommendation, made by Mr. Cushman, was referred to Committee A after their report had been made. The Committee, however, consider the recommendation subsequent to the adjournment and referred it to the Referee on potash for investigation.

I recommend that the Referee direct his attention to a study of what really constitutes available potash in soils, fertilisers, and ground-mineral products, so that, if possible, we may have a definition of available potash. The Referee, I understand, according to the precedents and rules of our Association, has the right to call in sub-referees, or at least other members of the Association, to aid him in making his report. If there were any machinery for doing it in the Association I think the matter so important that I would suggest the appointment of a representative Committee to study the question carefully ; but as it is I put it in the form of a recommendation that the Referee turn his attention to a definition of available potash.

5. SOILS.

It is recommended—

1. That the fifth-normal nitric-acid digestion method be further studied. (*Bull.* No. 46, p. 74, Sec. *i*, using nitric instead of hydrochloric acid, and digesting at 20° C. instead of 40° C.).

Adopted.

2. That the sodium peroxide fusion method for total phosphorus be given a further trial, and that this be compared with the alkali-carbonate fusion method. (Proceedings, 1995, *Bull.* 99, p. 111 ; details slightly modified in 1906 report).

Adopted.

3. That the modified J. Lawrence Smith method for total potassium, presented at this meeting, be further tested.

Adopted.

This method reads as follows:—The well known ammonium-chloride and calcium-carbonate fusion devised by J. Lawrence Smith is used (Fresenius, "Quantitative Analysis," p. 426). The fused mass is transferred to a porcelain dish, slaked with hot water, finely ground with an agate pestle, and transferred to a filter. After washing free of chlorides the filtrate and washings are concentrated in a Jena beaker to about 20 cc. Filtrate and washings are slightly acidified with hydrochloric acid, concentrated in a platinum dish, and 1½ cc. of a platinic-chloride solution (10 cc. contains 1 grm. of platinum) added where 1 grm. of soil has been used. This is then evaporated to a syrupy consistency as usual, and washed with 80 per cent alcohol and ammonium-chloride solution.

4. That line 30, under "1—Preparation of Sample," p. 71, *Bull.* No. 46, be changed from "openings ½ millimetre in diameter," to "openings 1 millimetre in diameter," and that "passed through a sieve of 1 millimetre mesh," be omitted from line 1 under (*k*), p. 74.

This change in an official method having been before the Association in 1905, was adopted.

5. That for "3—Determination of Volatile Matter," *Bull.* No. 46, p. 72, substitute the Determination of Total Organic Carbon (*Journ. Am. Chem. Soc.*, 1904, xxvi., 1640) as the official method.

Recommended for adoption as official in 1907.

6. That under (*k*), p. 75, *Bull.* No. 46, mark the official method "(*a*)," and insert the following:—

B. *Optional Provisional Method.*

Proceed as in (*a*) through "let stand a few minutes in the water-bath," and complete as follows:—

Filter into a beaker, add a drop or two of hydrochloric acid and 1 cc. of ammonium sulphate (75 grms. to 1 litre), digest several hours on water-bath, and filter into a tared platinum dish. Evaporate to *complete* dryness, heat to full redness, add 1 grm. of powdered ammonium carbonate, expel by heating, cool, and weigh the sulphates of sodium and potassium. Determine potassium in the usual manner.

Adopted.

6. Insecticides.

It is recommended that the methods submitted for investigation in 1905 be further studied. These methods are as follows:—

1. Work on London purple, special attention being given to the modifications proposed by Mr. Davidson for the removal of part of the colour.

Davidson's Modification.

Total Arsenious Oxide.—Place 2 grms. of London purple in a beaker, and dissolve in about 80 cc. of water and 20 cc. of concentrated hydrochloric acid at a temperature of 80°. Cool, and add sodium carbonate in slight excess, transfer to a 250 cc. flask, and bring to the mark; shake, and filter through a dry filter into a dry beaker; acidify 50 cc. with hydrochloric acid, and add sodium bicarbonate, titrating with iodine as usual.

Total Arsenic Oxide.—Acidify 50 cc. of the alkaline solution, prepared as described under "Total Arsenious Oxide," with hydrochloric acid, add 25 cc. of concentrated hydrochloric acid and 3 grms. of potassium iodide. Then proceed as directed under this determination in *Circular* 10, revised, Bureau of Chemistry, p. 4.

2. The hydrogen peroxide method for determining sulphur in sulphur dips and similar compounds, efforts being made to have all analyses made simultaneously.

3. The hydrogen peroxide method for determining formaldehyde in its modified form.

4. The methods of determining available chlorine in bleaching powder.

Motion carried.

PROBLEMS OF APPLIED CHEMISTRY.*

By Prof. GEORGE LUNGE.

It is one of the greatest honours I could covet to stand up in a room hallowed by the shades of some of the heroes of Natural Science, and to be privileged to speak on the theme I have selected. I feel that I ought to justify my claim to do so by the interest and importance of the subject. But I think it right to say at once that the title of this discourse, "Problems of Applied Chemistry," is in effect much too comprehensive, and should not be pressed home. A mere enumeration of such problems would be both tedious and useless; and how could anyone think of treating all of the more important of these problems within the space of sixty minutes? I shall have to confine myself to merely a few of those matters which might be fairly brought within the compass of the title of this lecture.

"Applied" in the narrower sense of "Industrial," Chemistry—means the pressing into service of chemical principles for practical purposes, such as the extraction of valuable matters from the three realms of Nature, and the conversion of such matters (if they cannot be put to any direct use) into numerous other useful substances. The science and art of the engineer are intimately interlaced with those of the practical chemist, so that it is difficult to say which of the two has to borrow most from the other in order to carry out his objects in the most efficient manner. So much is certain—an industrial chemist cannot exist, as such, without availing himself of the resources of the constructive arts. Even the laboratory of the purely scientific chemist in these days contains numerous mechanical appliances, without which (to quote only one instance) it would have been impossible to effect the glorious discoveries made in the laboratory of the Royal Institution, in the past generally, and more particularly in quite recent times. But what could the chemical *manufacturer* nowadays do without such assistance? The practical, as distinguished from the scientific, chemist possesses, or is supposed to possess, sufficient knowledge and experience to see to the working of machines and to minor repairs without calling in an engineer, save in difficult or complicated cases, or where the work is carried out on such a scale that the services of a specialist are required, and that it pays to employ one. If a chemist lacks such knowledge, or possesses it in too limited a degree, he will have to be content to remain in the laboratory and to do the ordinary "testing," which is both a tedious and a badly-paid occupation. I am told that in this country this is far more frequently the case than either in America or on the Continent; but I must refrain from pronouncing an opinion as to how far this is due to the ordinary training of the chemists, and how far to the jealous reluctance of many unstudied managers to afford the chemist access to the real factory work, lest he acquire sufficient routine in that work to supplant themselves.

Well, granting the opportunity, how can a chemist gain experience in conducting operations on a large scale? Various ways are open for this purpose. In former times the chemical manufacturer (who only in very exceptional cases deserved to be called a real chemist) learned his trade, both on the chemical and the engineering side, as far as it was indispensable; but he learned it simply "by rote," as the saying goes. He would enter a factory as apprentice or volunteer, and there he had an opportunity of witnessing, not merely all the chemical operations, but also the building of sheds, the setting of pans and of steam boilers, the erection of the simple machinery of those days, the construction of furnaces for chemical purposes, and similar matters, and he was expected to use his hands like any ordinary workman. If he was clever and industrious, he learned in the course of years, not merely to direct the various operations at the works, but also to make improvements in details, and, perhaps, if all went

* A Discourse delivered at the Royal Institution, March 15, 1907.

well, in more important matters. To be sure, it is notorious that this never took place without large sums of money being thrown away, either in the form of misshapen or faulty apparatus and machinery, or of spoilt chemicals, and so on. And this happened to the unstudied "practical man," who, through family connections or by mere chance, had stumbled into chemical manufacturing, as well as to men who had studied the science of chemistry, and who desired to apply the knowledge thus gained to the execution of some well-known process, or to the working of some laboratory invention on a large scale. Those men who possessed a scientific foundation, were, in their turn, compelled to learn the technical side of their profession by dint of practice, just as the tailor has to learn the art of making clothes and the barber the art of shaving. A man of scientific attainments had certainly, even in the olden times, a clear advantage over the mere "practical man." He was able to make a chemical examination of his first materials, of the intermediate products, and of the finished merchandise. Sometimes, although by no means invariably, he could more easily manage to ascertain the causes of disturbances in the manufacturing processes, and to put these right again; and often he was able to effect savings and improvements in these processes. But this advantage only held good in such cases where the chemical reactions, as such, came into play; whilst in those cases where the mechanical side prevailed, the studied chemist, for the most part, showed less quick insight and resource than the unstudied foreman or manager, with the ultimate result that he wasted quite as much money over failures as the others did. And it is not difficult to understand that such failures happened even to eminent scientific chemists who attempted to carry out their ideas on a large scale. Their ignorance of the proper ways for translating a laboratory method into a manufacturing process was at that time remedied only in exceptional cases by the advice of an engineering expert. If such an expert was actually consulted he often did not succeed in his task, because chemical operations were outside his province, and because he tried to apply certain means, suitable to cases with which he was familiar, in cases of an entirely different nature. On the whole, the chemical manufacturer of those days felt at every turn the pinch of a mere routine experience, gathered piecemeal during the course of his daily work.

This state of affairs continued until about the middle of last century, or a little later—to be sure with marked differences in details, both in respect of local conditions and in the nature of the manufacture. To begin with the latter, we perceive that then, as indeed from the very first, several branches of chemical manufacture had their full share in the progress of mechanical engineering. To name only a few of these, we may refer to the vast field of metallurgy, to the manufacture of coal-gas, and to the extraction of sugar from beet-roots. But precisely in these cases we cannot find much proof of co-operation between the chemist and the engineer, for the former had very little to say in these industries at that time, and in most of these establishments his services were dispensed with, whilst all the resources of mechanical engineering were fully applied. The managers of such works did not come from the ranks of the chemists, but from those of the mechanical engineers; and even now that chemistry has established its proper influence upon those industries, and has produced great revolutions in them, that state of things has remained very much as before. Many other branches of manufacturing, which undoubtedly have a chemical basis, and in which to-day a large number of chemists are actually employed, were in those days carried on in a purely empirical manner, like any handicraft. I instance soap-making, tanning, brewing—indeed, all those industries which are connected with food—and above all, dyeing and tissue-printing. But towards the end of the period which we have so far had in view, we perceive the commencement of a scientific treatment of those industries. Even before then, the genius of Chevreul had thrown a flood of light on the chemical behaviour of fatty substances, and Persoz followed in the domain of dyeing fabrics. On the other hand, the more intelligent manufacturer of chemicals gradually ceased to entrust the construction of apparatus to ordinary tradesmen, and began to seek the assistance of trained engineers, so as to obtain apparatus constructed in the most rational way, and so to effect a saving in space, time, fuel, and labour. This co-operation of the various arts and sciences was distinctly promoted by the technical high schools in France and Germany, more especially the Ecole Centrale at Paris founded in 1830, and the Polytechnics at Karlsruhe, Vienna, Hanover, and Zürich, which sprang into being during the ensuing twenty-five years.

In Great Britain matters took a somewhat different course. Here the chemical industries had from the first taken their full share in the astounding development of all branches of industry which in this country has for several centuries enjoyed an uninterrupted peace, whilst continental Europe was lacerated by frequent wars, above all by the storms raging during a quarter of a century in the wake of the French Revolution of 1789. Napoleon's attempt to create industrial progress by special legislation, and by hermetically shutting off the Continent from intercourse with England, was not crowned with success; and the industries artificially nursed by his policy mostly collapsed when, on the conclusion of peace, English merchandise was once more freely imported into France, Germany, and other countries. Thus, Great Britain had a long lead in all the fields of commerce and industry.

Some of the most important of the chemical industries have, indeed, altogether originated in this country, especially that of sulphuric acid and that of chloride of lime, both of which date back as far as the eighteenth century. But it is only fair to remember that some of the most important improvements in these manufactures are due to French inventors and French scientists. Not only that, but we must bear in mind that to France we owe the invention of the Leblanc process, which for three-quarters of a century has enjoyed a practical monopoly in the manufacture of alkali. It is curious to notice how, in this case, England has reciprocated the services rendered to her by France by the development of the other chemical industries just named. The Leblanc process, invented in 1791, and carried out on a large scale in France a few years later, could not be at once introduced into this country, owing to the fact that its first material, common salt, was burdened with an absolutely prohibitive excise duty. The abolition of this tax in 1823 acted like the wave of a magic wand, not merely in calling into life the manufacture of alkali itself, but by giving a strong impetus to all the chemical industries connected therewith, viz., those of sulphuric, hydrochloric, and nitric acid. Almost immediately the tide of inventions and improvements set in, and a few decades later we find Great Britain absolutely dominant, not merely in the branches just mentioned, but generally in the field of inorganic chemical industries. For many years, up to 1870 about, this predominance was not seriously called into question.

This splendid achievement Great Britain owes, in the first place, to the energy, business capacity, and general practical ability of her sons; and, in the second place, to her very much greater freedom from the leading-strings of government, in comparison with Continental states; but, thirdly, also to the special talent possessed by many Britons in the mechanical direction, to their aptitude for seizing the essence of any machinery, and to their genius for inventing new mechanical contrivances and adapting them for purposes of manufacturing and locomotion. The nation to which mankind owes the inventions of the steam-engine, of railways and steam-boats, and the displacement of manual labour by machinery in spinning and weaving, and countless other industries, such as the substitution of the Bessemer process for hand-made wrought-iron, this same nation has, up to the third quarter of last century, also manifested the greatest progress in applied chemistry.

The British manufacturer, although in those times he had frequently not studied the science of chemistry, as such, has, nevertheless, always shown special aptitude for creating, so to say, intuitively, the most suitable apparatus for operating chemical processes, the principle of which may have been discovered elsewhere.

In this manner inorganic chemical industry was developed in Great Britain up to the middle of last century to a greater extent than in any other country, by men like the Muspratts, Tennant, Gossage, Dunlop, Chance, and many others. Most of them were neither studied chemists nor engineers, but in their school any theoretically educated chemist could immensely profit for the work of factory-manager.

In close connection with this state of matters we find in England among the greatest inventors men who, at the outset, did not even possess a routine knowledge of the field in which they achieved their later successes, and who were altogether "outside the profession." Walter Weldon, the reformer of the industry of chlorine, was a journalist of high literary culture, but originally of a very slight amateur knowledge of chemistry, and not at all acquainted with practical manufacturing. Henry Bessemer was a brass-founder who, during the earlier part of his life, had nothing to do with iron. Sidney Gilchrist Thomas was a clerk in the War Department, who had never seen an iron-works when he made his epoch-making invention, and who had acquired his knowledge of chemistry and metallurgy in his spare time after office hours which most of his colleagues in England spent in the pursuit of sport, and many of his Continental colleagues in the beer-house or the wine-tavern.

(To be continued).

PROCEEDINGS OF SOCIETIES

PHYSICAL SOCIETY.

Ordinary Meeting, March 8th, 1907.

Prof. J. Perry, F.R.S., President, in the Chair.

A paper by Prof. F. T. Trouton and Mr. S. Russ on "*The Rate of Recovery of Residual Charge in Electric Condensers*" was read by Prof. Trouton.

The experiments described by the authors were undertaken in order to examine the rate of recovery of residual charge when the difference in potential of the plates is kept constant. Previous experimenters have always allowed the charge to accumulate on the plates while observing the rate of rise in potential. In that case the recovery meets with an ever increasing opposition which complicates matters. The authors have employed two methods. In the first, which was used with mica condensers, the potential, observed by an electrometer, was kept constant by means of a variable resistance which was gradually increased as the recovery current diminished. The high resistance necessary was constructed of two horizontal metal plates with ionised air between them. A movable shutter could be introduced between the plates to gradually diminish the cross section of the air resistance as required. The second method was used when the residual charge was great enough. In it the current was passed through a dead-beat galvanometer, and the value of the recovery current at each moment determined. In this case the difference of potential of the plates may be taken as constant since it was practically zero. The observations when plotted with current against time were found to lie on a hyperbola. This shows that under the circumstances of the experiments the quantity of electricity recovered up to any given time follows a law $Q = a \log (p+t)$ similar to that found by Rankine and others for the recovery of stress in overstrained elastic bodies when the strain is kept constant.

The Chairman said that together with Prof. Ayrton he had carried out a series of experiments on this subject which were described in the *Proceedings of the Royal Society* (vol. xxx.). Observations were made upon strained materials, Leyden jars, and voltameters, with the object of testing Maxwell's law. The current flowing into or from the condenser was kept constant and equal to zero, and under the conditions of the experiments the solution of Maxwell's differential equation gave for the potential v between the surfaces of the condenser the equation—

$$v = A + Be^{-\beta t} + Ce^{-\gamma t} + \ldots$$

If β was less than γ, γ less than δ, and so on, then after certain intervals of time certain of the terms became unimportant, and if the time were sufficiently large the equation for v reduced to—

$$v = A + Be^{-\beta t}.$$

He was of opinion that if the higher terms in the expression for v were maintained it would be found that the results obtained by the authors could be made to fit a formula deduced from Maxwell's theory. It was necessary to exercise caution in the selection of an empirical formula to represent the results of experiments. Two very different formulæ would often over a moderate range fit a series of results equally well.

Mr. A. Campbell said the method of using ionised air for a variable and adjustable resistance was very ingenious. A somewhat similar use of ionised air as a constant high resistance was made by Prof. McClelland (Royal Dublin Society, Feb., 1904), who found such a resistance most useful in comparing very small capacities. In the case of the celluloid and paper condenser the effects must be partly electrolytic, for moisture is present as an important factor. This might even be true in the case of a mica condenser in which the tin-foil does not make extremely good contact with the dielectric and where creeping charges might occur. Thus the effects described in the paper may not be truly dielectric.

Mr. Rollo Appleyard remarked that in the absence of details regarding the condenser it was difficult to discover how nearly or how remotely the dielectric sheets in the authors' experiments were analogous to test bars submitted to mechanical stresses in Prof. Rankine's investigations. The authors stated that their condenser was constructed of "celluloid sheets, in conjunction with layers of paper, laid on either side." This leaves in doubt the nature of the material of the conducting surfaces and the effectiveness of the contact between those surfaces and the dielectric. If it happened that the contacts were imperfect the results must be held to relate as much to what transpires at the surface as to any action within the material. Imperfect electrical contact must be regarded as analogous to mechanical slip, and the equations must be modified accordingly. Celluloid is a dielectric which, when tested between electrodes making perfect contact, exhibits practically no "electrification"; and from this it is safe to predict that it will exhibit very little residual-charge effect. After receiving the proof of the paper he (Mr. Appleyard) carried out some tests upon a sheet of celluloid 0·177 cm. thick with circular electrode surfaces 14 cm. diameter. The total pressure on the upper tin-foil electrode was 3170 grms., and the temperature 20° C. The results obtained are shown in the accompanying table.

A comparison of the above figures with the results arrived at by the authors seemed to break new ground, and a study of the differences should lead to a better understanding of these phenomena. As the authors worked with only 20 volts the attractive force between the electrodes and the dielectric would be less than in the above case. In the paper the authors had expressed their results in an arbitrary unit of time, so that it was impossible to determine whether in this respect his results agreed with those of the authors. An arbitrary unit of current had also been adopted by the authors.

Mr. W. A. Price expressed his interest in the paper,

Volts.	Galvanometer deflection after— One min.	Two mins.	Three mins. (Battery removed at two mins.).	Resistance between electrodes (megohms).
		Mercury Electrodes.		
176	118	118	−0·5	80·5
289	232·5	232·5	−0·5	67·0
442	348	348	−1·0	68·5
600	464·5	464·5	−1·0	69·7
		Tin-foil Electrodes.		
176	28	31	0·0	339
289	134	143	0·0	116
442	293	302	0·0	81
600	471	480	+1·0	69

and asked if the authors could give a physical explanation of the phenomena described.

Prof. TROUTON said, in reply to the Chairman, that they had tried to represent their results by an exponential expression, but the result was not nearly so good as that obtained from the formula given in the paper. Of course with more constants an exponential expression could be used. He had found that their formula fitted the results of the Chairman and Prof. Ayrton. In reply to Mr. Campbell and Mr. Appleyard he said that possibly there might be electrolytic action, but most of the phenomena described were due to residual-charge effects. With reference to the units, he said the times were expressed in seconds, but the unit of current was arbitrary.

The remaining papers on the agenda were postponed.

NOTICES OF BOOKS.

The Toxins and Venoms and their Antibodies. By EM. POZZI-ESCOT. Authorised Translation by ALFRED I. COHN, Phar.D. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1906.

THIS book contains an account in outline of the action of toxins and venoms considered mainly from a physiological point of view. The substances which the author treats include, not only the true toxins, but also various nitrogenised alkaloidal bases which have strong toxic properties and appear to be the products of the decomposition of true toxins. The latter are sub-divided into—(1) Vegetable and Animal Toxins, (2) Microbial Toxins, and (3) Venoms, and in each class the characteristic properties and symptomology are shortly described, and the question of immunity is also considered; the chemical nature of toxins and allied substances, however, is passed over, and the whole treatment is very slight. The little book may perhaps be useful as a short *résumé* of the very important work which has recently been done on the toxins, but there are omissions and misprints which call for rectification in a later edition. Thus, no account of cantharidine is to be found, though the poisons of wasps, bees, scorpions, &c., are noticed, and the poison of the mussel, mytilotoxin, is misnamed methylotoxin on the last page.

Inorganic Qualitative Chemical Analysis. By WILLIAM STOWELL LEAVENWORTH, M.Sc. Easton, Pa.: The Chemical Publishing Co. London: Williams and Norgate. 1906.

THE output of text-books of qualitative anyalsis has reached a very high level in recent years, and the appearance of every new book on the subject awakens in the mind the doubt whether there is room for yet another. The examination of this book enables us to give a favourable answer as to its right of existence, although not without reservations, in view of the similarity in scope and style between it and many other practical text-books. It occupies an intermediate position between a skeleton outline of the subject and a lengthy detailed treatise, and the author has done a very useful work in endeavouring to develop the student's independence of thought and initiative. It is made impossible for him to do his work mechanically, and at every turn he is forced to think and reason for himself. Thus, he devises his own scheme of analysis which is fixed in the memory by means of clear outlines of the groups. Organic salts are used as the group reagents for the detection and separation of inorganic acids, and thus the use of inorganic acid salts in the separation of the groups is altogether avoided. The appendix gives full data concerning the strengths of solutions used, and also contains a discussion of the reactions of some rare metals, and on the whole the book is at least not inferior in value to some of the best of its kind.

Food for Plants. By HARRIS and MYERS. New Edition, with Supplementary Notes. New York: William S. Myers, F.C.S.

THE authors of this book succeed in making out a strong case in favour of the use of nitrate of soda as a fertiliser. The most satisfactory methods of applying it are emphasised, and various rules are given which the farmer is advised to follow carefully; moreover, the Bulletins of different Agricultural Experimental Stations are quoted to show the results of the many experiments which have been made in the use of this fertiliser. Most of the information and hints would appeal to the American farmer rather than to the English agriculturist, who has recognised the value of nitrate of soda, and uses it freely. The illustrations are very telling, and the applications of nitrate to all classes of crops are considered, while numerous results of the analysis of all kinds of manures are tabulated.

CORRESPONDENCE.

BIOTIC FORCE.

To the Editor of the Chemical News.

SIR,—In considering the possibility or otherwise of vital force, recently called biotic force, expressing a special form of energy, we should keep in view the fact that bio-chemical changes in their essential take place at infinitely small distances among highly complex molecular structures, and that physico-chemical processes may gradate in a manner not at all attainable in the inorganic world.

Biotic force, if such exist, should, we might think, present some relationship to nervous force, as expressing a transference of energy, and the latter force has before now been associated in its manifestations with those of electrical energy.

As regards the mechanism of metabolic changes a graphic picture is given by Macalister as follows:—

"All protoplasm is capable of being stimulated to metabolism and the discharge of energy by external agencies, but in the differentiation that characterises the development of animals, a physiological division of labour takes place in many cells, whereby the contractibility of one part of the apparatus becomes intensified, constituting molecular tissue, while the capacity of receiving sensations becomes concentrated in other cells of the surface-layer."

It might be suggested that a mere question of relatives as applied to the space in which bio-chemical changes take place is sufficient to account for vital phenomena as resulting from the application of the already admitted forms of energy, and the difference in the manifestation of these forms of energy from those taking place in the inorganic world.

At the same times, caloric energy is, perhaps, of the known forms, the most usual concomitant with vital manifestation, is always associated with the transformation of chemical energy into mechanical and physiological work, and can itself induce chemical action.

Hence, from the known forms of energy we may say that these themselves may account for all the changes taking place in physiological action and ask if the present experimental evidence and scientific deduction is sufficient to warrant the establishment of a new form of energy, the manifestations of which are due to biotic force.—I am, &c.,

J. C. THOMLINSON.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 10, March 11, 1907.

Direct Dehydration of Dimethylisopropylcarbinol, $(H_3C)_2C(OH)-(CH_3)_2$.—Louis Henry.—The direct dehydration of dimethylisopropylcarbinol produces tetramethylethylene. The process was carried out by first obtaining the tertiary alcohol by the action of magnesium methyl bromide upon ethyl isobutyrate and then dehydrating with acetic anhydride. On distillation, a liquid boiling at 56—58° was obtained, and another boiling at 72—73°, being three-quarters of the whole product. Thus the operation acts in two ways:—(*a*) Methylisopropylethylene, $H_2C=C(CH_3)-CH<^{CH_3}_{CH_3}$, is formed, boiling at the lower temperature; (*b*) tetramethylethylene, $H_3C>C=C<^{CH_3}_{CH_3}$, is the main product, boiling at 72—73°.

An Accurate Method of Separation of Ammonia and Monomethylamine.—Maurice François.—Every method of preparation of monomethylamine furnishes it mixed with a considerable quantity of ammonia, which has to be eliminated. The author has found the use of yellow oxide of mercury most successful for the purpose, since it combines with ammonia to form ammonio-mercuric oxide, and leaves the monomethylamine untouched. It is equally applicable to other very volatile and gaseous amines, furnishing products absolutely free from ammonia. In the case of dissolved amines the product contains less than 2/1000 of ammonia. Both a dry and a wet method of purification of amines by mercuric oxide are described.

Constitution of Nitrogen Derivatives of Ethylbenzoylacetate.—A. Wahl.—The author describes certain compounds formed by the reaction between ethylbenzoylglyoxylate and phenylhydrazine under varying experimental conditions and with different relative proportions of the two components. Mixed in equimolecular quantities, an additional product, $C_{17}H_{18}N_2O_4$, is obtained, and, losing H_2O, becomes a monophenylhydrazone of ethylbenzoylglyoxylate, $C_{17}H_{16}N_2O_3$, a yellow crystalline body. It is found to be identical with ethylbenzeneazobenzoylacetate, and from this fact is deduced the constitution—

$$C_6H_5-CO-C(=N-NH\cdot C_6H_5)-COOC_2H_5.$$

The β-Chlorethyl and Vinyl Ketones. Fixation of the Sodium Derivatives.—E. E. Blaise and M. Maire.—It has been previously pointed out that the double bond of the vinyl ketones has very marked addition properties. It causes direct fixation of both primary and secondary amines and the various organic sodium derivatives. The sodium derivatives have always an alkaline reaction, and the vinyl ketones respond readily to the action of alkalis; hence one part of the non-saturated ketone is always polymerised, and from regard to the yield it pays better to react with the sodium derivatives not upon the vinyl ketones, but upon the corresponding β-chlorethyl ketones. The author describes the following operations:—1. Sodium acetyl-acetic ether reacting with β-chlorethylethyl-ketone produced ethyl-octanedione-2.6-methyloate, which was converted into the ring-compound, 3-ethyl-Δ_2-cyclohexanone-6-methyloate of ethyl:—

$$CH_3-CO-CH(CO_2C_2H_5)-CH_2-CH_2-CO-C_2H_5 \rightarrow CO_2C_2H_5-CH(CO-CH)-CH_2-CH_2-C(=CH_2)-C_2H_5.$$

2. Sodium acetyl-acetone reacting with β-chlorethyl-ethyl-ketone gave ethylone-3-octanedione-2.6, which yielded the ring compound 3-ethyl-6-ethylone-Δ_2-cyclohexanone:—

$$CH_3-CO-CH(CO-CH_3)-CH_2-CH_2-CO-C_2H_5 \rightarrow CH_3-CO-CH(CO-CH)-CH_2-CH_2-C(=CH_2)-C_2H_5.$$

3. Ethyl-sodium malonate reacting with β-chlor-ethyl-ethyl-ketone produced heptanone-5-oate of ethyl-1-methyl-oate of ethyl-2, and the corresponding dibasic acid, decomposing when heated to give γ propionyl-butyric acid:—

$$C_2H_5-CO-CH_2-CH_2-CH(CO_2C_2H_5)_2 \rightarrow C_2H_5-CO-CH_2-CH_2-CH_2-CO_2H \rightarrow CH_2(OH)-CH_2-C(=CH_2)-CH_2-CO-CH_3.$$

This reaction would afford an excellent method of preparation of δ-ketonic acids if δ-chloro-propionyl chloride were more readily obtainable.

MISCELLANEOUS.

Society of Public Analysts.—The Council of the Society of Public Analysts has recently appointed Mr. Julian L. Baker Editor in place of the late Dr. Sykes.

The French Government has just conferred the Cross of the Legion of Honour on Professor P. A. Guye, Director of the Laboratories of Technical and Theoretical Chemistry in the University of Geneva.

Business Announcement.—The old-established firm of H. K. Lewis has just completed an important extension of their premises at 136, Gower Street, by the inclusion of 24, Gower Place, adjoining. The two shops have been made into one, the older portion being utilised chiefly as the Secondhand Department, where surplus books from the Library and other secondhand stock may be inspected. The new shop faces Gower Street and Gower Place, and affords greater convenience to customers for inspecting the latest books in all branches of Medicine, Surgery, and general Science. The Library is entered from the end of the shop, and has three windows facing Gower Place. Subscribers are able to examine the books on the shelves when making exchanges, and convenience for writing or making extracts is provided, the idea being to make this department a reading room for subscribers, especially those residing in the suburbs or the provinces. The telephone in this room is free for subscribers' use. Lavatory accommodation is also provided. The premises, which will still be known as 136, Gower Street, are within a minute's walk of the Metropolitan Station, and the new Tube Station at the junction of Tottenham Court Road, Euston Road, and Hampstead Road is only a few minutes' distance. The termini of the Great Western, Great Central, London and North Western, Midland, Great Northern, and Great Eastern are thus within easy access, while the new north and south tubes and the numerous lines of omnibuses bring the south-western and southern districts within comfortable reach.

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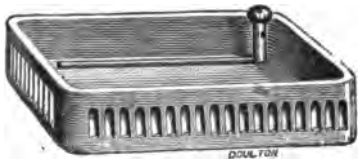

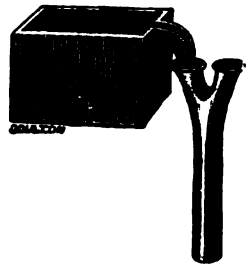

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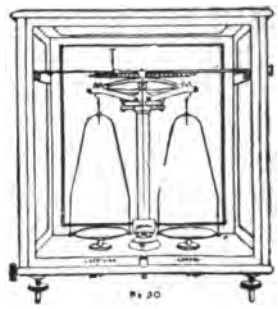

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A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 149).

Confirmatory Experiments and References (continued).

Solubility of Metastannic, Antimonic, and Silicic Acids in Ammonium Sulphide.—200 mgrms. metallic antimony and 300 mgrms. metallic tin were treated in separate experiments by P. 3 and the procedure described in Note 4: clear solutions were obtained on adding the acid solution to the alkaline ammonium sulphide solution.

The following experiments show that the residue from P. 3 may be treated directly with ammonium sulphide, but that this process is ordinarily a longer one than that described in the Note.

200 mgrms. Sn as dehydrated metastannic acid, previously heated at 120°, were warmed gently with successive 10 cc. portions of the ammonium polysulphide reagent in a covered casserole for five to ten minutes, with frequent stirring; in the first treatment considerably more than half of the tin dissolved; after the second treatment only about 20 mgrms. were left undissolved, and two more treatments dissolved this completely. The experiment was repeated, using colourless ammonium monosulphide in place of the yellow polysulphide, the same results were obtained.

500 mgrms. Sn as dehydrated metastannic acid were treated with successive 10 cc. portions of yellow ammonium sulphide in a pressure bottle at 70—80°; practically all dissolved in two ten-minute treatments.

200 mgrms. Sn as dehydrated metastannic acid dissolved in 10 cc. ammonium monosulphide in a pressure bottle at 80° in about ten minutes, and another portion of about 100 mgrms. Sn dissolved in the same solution on further heating.

200 mgrms. Sb as hydrated Sb_2O_5 previously heated at 120°, were treated in a covered casserole with ammonium polysulphide; it dissolved only very slowly, and several treatments were necessary to effect complete solution. As with metastannic acid, the use of the pressure bottle hastened the solution, but antimonic acid dissolved even less readily than metastannic acid.

100 mgrms. dehydrated silicic acid were warmed for fifteen minutes with 20 cc. ammonium monosulphide; the filtrate was acidified, evaporated to dryness, and tested for silica by P. 5; very little, if any, gas evolution was obtained, thus showing that SiO_2 is insoluble in ammonium sulphide. In another experiment only a few mgrms. (1 to 3) SiO_2 dissolved in 30 cc. boiling ammonia (0·96) in fifteen minutes.

P. 5, N. 2: *The Test for* SiO_2 *with* HF *and* H_2SO_4.—One and 2 m.grms. of dehydrated H_2SiO_3 were treated as described in the first paragraph of P. 5; evolution of gas took place at room temperature, and was easily seen in both cases.

One and 2 mgrms. SiO_2 as felspar, which had been well purified from free silica by long-continued boiling with Na_2CO_3 solution were treated in separate experiments according to P. 5; there was no evolution of gas in the cold, but a distinct one took place on warming.

500 m.grms. $BaSO_4$, 100 mgrms. TiO_2, 100 mgrms. tantalic acid, and 150 mgrms. niobic acid were treated by P. 5; no evolution of gas was observed in the cold nor on warming, provided the solid had been previously heated with the strong H_2SO_4 to remove air bubbles.

A filter (Schleicher and Schüll, No. 597) 11 cm. in diameter, with an ash stated to be 0·0028 grm., was treated by P. 2, to destroy organic matter, and the residue by P. 5, to test for silica; bubbles of gas were clearly seen.

In a series of experiments an attempt was made to test for silica by adding HF to the dry solid, and allowing the SiF_4 evolved to act on a drop of water held in the loop of a platinum-wire near the solid. The best conditions were found to be to add less HF than corresponded to the silica present, to allow the reaction to continue until almost all the HF was destroyed, the action being accelerated by stirring with a heavy platinum-wire, and then to warm the mixture gently, while holding the drop of water near the solid. Even under these conditions, however, the drop did not become turbid when less than 5 mgrms. SiO_2 were used, although an evolution of gas doubtless took place, as was shown by a hissing sound.

P. 5, N. 3: *Action of Hot* H_2SO_4 *on Platinum.*—Five cc. H_2SO_4 (1·84) were evaporated to 2 cc. in an open platinum crucible within two or three minutes, cooled, diluted with 5 to 10 cc. water, and H_2S passed into the hot solution for some minutes; a brown coloration appeared quickly, but no precipitate settled out.

Five cc. H_2SO_4 (1·84) were boiled for fifteen minutes in a covered platinum dish previously weighed, cooled, diluted, and saturated hot with H_2S; a precipitate of PtS_2 estimated to contain 2 to 3 mgrms. Pt was obtained, and the dish had lost 3 mgrms. in weight.

P. 5, N. 4: *Action of* H_2SO_4 *and* HF *on Minerals and other Substances.*—Each of the following substances was treated with the stated result by the following procedure, which is similar to the regular process, P. 4—6, except that in these experiments the substance was digested for a longer time with hot concentrated H_2SO_4. One grm. was digested for several minutes in a covered platinum dish with 10 cc. HNO_3 (1·42). Three cc. H_2SO_4 (1·84) were then added, the mixture was evaporated to distinct fuming, and maintained at that point for ten minutes. Five cc. HF were added, the mixture was digested for fifteen minutes on a water-bath, and then evaporated until thick acid fumes were given off; 3 cc. HF were added, and the mixture was again evaporated to fuming. Thirty cc. water were added, the mixture was boiled for fifteen minutes, cooled, diluted to 100 cc., and the residue washed once by decantation. Thirty cc. saturated Na_2CO_3 solution were then poured over the residue, and the mixture was allowed to stand, with frequent stirring, for fifteen minutes. The solution was decanted, and the residue washed twice with water, after which it was treated with 30 cc. HCl (1·02). A large residue was left after the final treatment with HCl by cassiterite SnO_2, emery Al_2O_3, chromite $FeO.Cr_2O_3$, rutile TiO_2, cinnabar HgS, molybdenite MoS_2, tourmaline, beryl $Be_3Al_2Si_6O_{18}$, and columbite $Fe(Nb,Ta)_2O_6$. About a third of the molybdenite was decomposed by the HNO_3 with separation of some molybdic acid, which dissolved in the H_2SO_4. Cinnabar, rutile, and beryl were much attacked by H_2SO_4, and columbite by HF, but the other substances were attacked not at all, or only very slightly, by any of the reagents:—Fluor-spar CaF_2, chrome yellow $PbCrO_4$, wulfenite $PbMoO_4$, and vanadinite $3Pb_3V_2O_8.PbCl_2$, were attacked by HNO_3 and by H_2SO_4; titanite $CaTiSiO_5$, garnet $(Ca,Mg,Mn,Fe)_3Al_2Si_3O_{12}$, a cement, and some slags containing lead or calcium, were attacked by these acids, and also by HF. All left, after the treatment with HF and H_2SO_4, a white residue, which, after the treatment with Na_2CO_3, dissolved completely in HCl. The white residue therefore contained only insoluble sulphates, such as $PbSO_4$,$CaSO_4$; and the substances were completely decomposed by the treatment with HNO_3, H_2SO_4, and HF:—Wolframite $(Fe,Mn)WO_4$, menaccanite $FeTiO_3.Fe_2O_3$, and Prussian blue were decomposed by H_2SO_4, and all left a residue insoluble in dilute H_2SO_4, which dissolved completely, or nearly so, in Na_2CO_3:—Magnetite Fe_3O_4, cryolite Na_3AlF_6, basalt, granite, monazite, a uranium ore, and a number of slags were

* From the *Technology Quarterly*, xix., No. 3 September, 1906.

completely decomposed after the treatment with HNO_3, H_2SO_4, and HF, and dissolved completely in the dilute H_2SO_4.

For the action of HF and HNO_3 on some other difficultly soluble native silicates, see *Technology Quarterly*, 1903, xvi., p. 126; also CHEMICAL NEWS, xciii., p. 173.

P. 5, N. 4 and 5: *Solubility of Sulphates in Concentrated and Dilute* H_2SO_4.—100 mgrms. and 150 mgrms. Ba as $BaSO_4$ were strongly heated with 2 cc. concentrated H_2SO_4; a clear solution resulted in the first case, but not in the second. $BaSO_4$ was precipitated at once when a little water was added.

For the solution of $PbSO_4$ in concentrated H_2SO_4, see C. E. on P. 26, N. 1.

Ten, 15, and 20 mgrms. Ca as $Ca(NO_3)_2$ were added in separate experiments to 20 cc. H_2SO_4 (1·20); with the 20 mgrms. a precipitate separated at once, and with the 15 mgrms. after about five minutes, while with the 10 mgrms. none formed, even after several hours.

300 mgrms. Al, 300 mgrms. Fe, 100 mgrms. mercuric Hg, and 150 mgrms. Cu, all as sulphates, were in separate experiments boiled with concentrated H_2SO_4, cooled, diluted, and again boiled as described in the Procedure; the anhydrous $Al_2(SO_4)_3$ and $Fe_2(SO_4)_3$ dissolved completely after about three minutes' boiling; the anhydrous $CuSO_4$ and the $HgSO_4$ dissolved at once on warming.

To 100 mgrms. Cr as $Cr_2(SO_4)_3$ in solution as green sulphate 2 cc. H_2SO_4 (1·84), were added, and the solution was evaporated until thick acid fumes came off; the mixture was cooled, diluted, and boiled, the whole treatment being as in the Procedure; the resulting solution was green, and from its colour was estimated to contain 10 to 15 mgrms. Cr; the remainder of the chromium was left as a very finely divided light pink powder, anhydrous $Cr_2(SO_4)_3$:—This experiment was repeated, except that the H_2SO_4 was heated only until slight fumes appeared; no pink precipitate separated, and on boiling with water a clear green solution was obtained.

100 and 200 mgrms. Cr as precipitated $Cr(OH)_3$ were dissolved in 5 cc. H_2SO_4 (1·84) and 20 cc. water; the solutions were evaporated to about 2 cc., cooled, diluted, again boiled, and filtered; a very finely divided grey to pink powder, anhydrous $Cr_2(SO_4)_3$, was obtained, which ran through the filter. The precipitate was allowed to settle, and the solution was decanted and boiled with NH_4OH; it was colourless, and gave scarcely any precipitate of $Cr(OH)_3$. The anhydrous sulphate was boiled for fifteen minutes with dilute H_2SO_4; only a few mgrms. dissolved. The sulphate was found to be slowly dissolved by a concentrated Na_2O_2 solution owing to oxidation to chromate.

500 mgrms. Sb as $SbCl_3$, 50 mgrms. antimonic Sb ($SbCl_3$ previously boiled with HNO_3 and HCl), and 500 mgrms. Bi as $Bi(OH)_3$ were heated in separate experiments with 3 to 5 cc. H_2SO_4 (1·84), evaporated to 2 cc., diluted to about 20 cc., and again boiled. With the antimonous salt a crystalline precipitate was obtained on evaporating the H_2SO_4 solution; this precipitate dissolved when the 20 cc. water were added, but an amorphous precipitate formed when much more water was added. The antimonic antimony was precipitated in the concentrated H_2SO_4 as an amorphous powder, and more of this precipitate separated on dilution; the dilute H_2SO_4 solution was filtered, and the amount of antimony contained in the filtrate was estimated by precipitating with H_2S to be about 10 mgrms.; the residue insoluble in H_2SO_4 was washed with water, and dissolved in boiling HCl, and to the solution $BaCl_2$ was added; only a slight precipitate of $BaSO_4$ was formed, showing that the residue was an oxide or hydroxide, not a sulphate. In the experiment with bismuth the hydroxide dissolved in H_2SO_4, and a crystalline precipitate (sulphate) separated from the hot concentrated H_2SO_4, but the larger part of this dissolved on adding the water, provided the solution was kept cold; a precipitate (of oxysulphate) appeared when this solution was heated; the filtrate from this was treated with NH_4OH, and a precipitate was obtained which was estimated to contain 20 to 50 mgrms. Bi.

P. 5, N. 6: *Decomposition of Silver Salts by* H_2SO_4.—500 mgrms. Ag as precipitated AgCl, 500 mgrms. Ag as fused AgCl, 100 mgrms. Ag as precipitated AgCN, and 100 mgrms. Ag as precipitated AgI were treated with H_2SO_4 as described in P. 5; there was a residue in each case. HCl was added to the H_2SO_4 solution; a small precipitate of AgCl was then obtained, showing that some of the silver salt had been decomposed. The residues were boiled with 5 cc. H_2SO_4 (1·84) in a covered casserole for several minutes; AgI and AgCN dissolved readily in less than five minutes, and almost all the AgCl in less than ten minutes.

500 mgrms. Ag as AgCl were boiled with Na_2CO_3 solution (as described in P. 6) for fifteen minutes; the AgCl precipitate quickly turned black. The Na_2CO_3 solution was acidified with HNO_3, and $AgNO_3$ added; a precipitate of AgCl, estimated to contain 2 mgrms. Ag, formed, showing that only this amount of Ag as AgCl had been converted into silver oxide.

(To be continued).

DAIRY PRODUCTS, FOODS AND FEEDING-STUFFS, SUGAR, TANNIN, AND MEDICINAL PLANTS AND DRUGS.*

REPORT OF COMMITTEE B.—(E. B. HOLLAND, *Chairman*).

1. MEDICINAL PLANTS AND DRUGS.

IT is recommended—

1. That the present provisional method for the assay of opium products be made official. (Proceedings, 1905, *Bull.* 99, p. 162; *U. S. Pharmacopœia*, Eighth Revision, p. 329, with additions).

Referred to the Referee for 1907 for recommendation and final action by the Association.

2. That the present line of work be continued by the Referee on medicinal plants and drugs.

Adopted.

2. FOODS AND FEEDING-STUFFS.

It is recommended—

1. That the König and modified König method for crude fibre be dropped. (See Proceedings, 1903, *Bull.* No. 81, p. 38).

Adopted.

2. That the slightly modified Ellett-Tollens method for methyl-pentosans be tested again next year by the Association. (*Z. Landw.*, 1905, liii., [1], 13).

Adopted.

3. Upon motion by Mr. Peter, the Association voted to instruct the Referee for 1907 to study the temperature and time of drying of ether extracts.

Passed.

3. DAIRY PRODUCTS.

It is recommended—

1. That the method of double extraction be adopted as provisional for the determination of fat in condensed milk, the directions to be given as follows:—

Fat.—Extract the solid residue of about 5 grms. of a 40 per cent solution with ether in the usual manner; dry, leave tubes in a dish containing 500 cc. of water or more, for two or three hours; dry, extract again for about five hours, and determine fat as under Milk. (*Bull.* 46, p. 54).

Adopted.

2. That the Gottlieb method (*Landw. Versuchs. Stat.*, 1892, xl., 1) be made provisional for the determination of fat in milk.

Referred to Referee for 1907 for further recommendation.

* Extracts from the Proceedings of the American Association of Official Agricultural Chemists, 1906.

3. That the conversion factor for protein in milk and dairy products be changed to 6·38 throughout the methods.

Referred to committee on unification of terms for reporting analytical results.

4. That the study of methods of analysis of condensed milk be continued with special reference to the determination of lactose and sucrose in the sweetened product.

Adopted.

4. Sugar.

Recommendations Pending from 1905.

The following recommendations are made in regard to questions referred from 1905 for action. (See Proceedings, 1905, *Bull.* 99, pp. 18—25, p. 155; *Circular* 26, p. 5):—

Chemical Methods.

1. That the methods selected by the International Committee for unifying sugar analysis, now provisional, be made official with the exception of paragraph 7, which should be eliminated, and paragraph 8, upon which action should be deferred. (See Proceedings, 1902, *Bull.* No. 73 Bureau of Chemistry, p. 58).

Adopted.

2. That action upon recommendations 3 and 4 be deferred until 1907. These recommendations are as follows:—

3. That method (*a*) for the determination of copper in the cuprous oxide precipitate, requiring reduction in hydrogen (see *Bull.* No. 46, p. 37) be dropped as an official method of this Association.

4. That methods (*c*) and (*d*) for the determination of copper in the cuprous oxide precipitate, requiring the electric deposition of the metal (see *Bull.* No. 46, p. 38), be dropped as official methods of the Association.

Action deferred as recommended.

3. That action for the adoption of Low's thiosulphate method for determining copper in the cuprous oxide be deferred until the original method and its modification be compared by the Association.

Adopted.

Molasses Methods.

Of the five recommendations deferred from 1905 for action, No. 1 is covered by recommendation No. 3 under general recommendations on sugar, 1906, which follows, while action on Nos. 2, 3, 4, and 5 is deferred until further co-operation is obtained from interested chemists. (See *Circular* 26, p. 5, or *Bull.* No. 99, p. 24.

General Recommendations, 1906.

It is recommended—

1. That further work be done upon the comparison of moisture methods for molasses and massecuites before action be taken by the Association.

Adopted.

2. That when increased accuracy is desired in the determination of reducing sugars in commercial products on account of the danger of contamination in the precipitated cuprous oxide, only such methods be followed as provide for a direct determination (electrolytic or volumetric) of the reduced copper.

Adopted.

3. That in the optical methods for the analysis of dark coloured massecuites, molasses, and other low grade products, the normal weight of substance may be made to some multiple of 100 cc., according to the extent necessary for accurate polarisation. This normal weight may be weighed out directly and made up to the desired volume, or taken from a solution prepared by dissolving a larger amount of the material (50 to 100 grms.) with water to a definite weight or volume. The latter method is to be preferred with non-homogeneous materials, such as massecuite, to secure greater uniformity of sample.

Adopted.

4. That in the estimation of sucrose by the gravimetric method the calculation by the factor 0·95 (*Bull.* 46, p. 39, bottom line) be made only upon the reducing sugars estimated as invert sugar. In making this calculation reducing sugars previously present, which require to be subtracted, must also be expressed as invert sugar.

Adopted.

5. Provisional: That reducing sugars in mixtures either before or after inversion may also be expressed as dextrose, in which case the calculation of the true percentages of sucrose and other sugars may be made by appropriate conversion factors and formulæ. (Browne, "Analysis of Sugar Mixtures," *Journ. Am. Chem. Soc.*, April, 1906).

6. Provisional: That for the estimation of dextrose, invert sugar, maltose, and lactose, under uniform conditions of analysis, the method and table of Munson and Walker be adopted provisionally by the Association. (Munson and Walker, "Unification of Method for Reducing Sugars," *Journ. Am. Chem. Soc.*, June, 1906).

Upon the suggestion of the Referee action on recommendations 5 and 6 was deferred, since but little co-operative work had been done.

7. That the questions of the influence of the lead precipitate, and the use of hypochlorites, hydrosulphites, and other agents for decolorising in optical analysis, and the use of clarifying agents before estimating reducing sugars, be investigated further before decisive action is taken by the Association,

Adopted.

8. That the co-operation of sugar chemists not members of the Association be invited, to secure a greater expression of opinion upon matters pertaining to improvement of analytical methods.

Adopted.

5. Tannin.

1. The report of the Referee on tannin was not received until after the report of Committee B had been made, but it was considered by the committee and a supplemental report made by Mr. Kebler in regard to the recommendation of the Referee that "the tannin section of the Association of Official Agricultural Chemists abandon the appointment of referee and associate referee and omit supervision of the tannin method." The committee recommended that the tannin work of the Association be continued, and the recommendation was adopted by the Association.

2. Upon motion by Mr. Veitch, the method on tannin submitted by the Referee in 1905 (*Bull.* No. 99, p. 123), as revised by the committee on revision of methods, 1906, was adopted as a provisional method, the changes made by the committee being almost exclusively in manner of statement, &c.

PROBLEMS OF APPLIED CHEMISTRY.*

By Prof. GEORGE LUNGE.

(Continued from p. 153)

Peculiar to England is also the following case, very different from those just quoted, but also illustrative of the ways of British inventors. William Henry Perkin, whose jubilee was celebrated last year amid the concourse of all civilised nations, had, at the early age of sixteen, entered Hofmann's laboratory in London. Already, two years afterwards, whilst working at the synthesis of quinine (a task not accomplished up to date), he discovered the colouring matter called "mauve," the forerunner of all colours produced from coal-tar: and only a year later, at an age when, on the Continent, the great majority of young men are either still at school, or at least entirely innocent of any taste for practical life, and when they only enter upon their theoretical studies, he built a factory for producing his mauve, which at once proved a success and

* A Discourse delivered at the Royal Institution, March 15, 1907.

laid the foundation for his splendid work in after life. This is not the place to enlarge upon his later career, which is almost unique in combining inventive genius with the true spirit of pure science.

We need not be surprised to find that sometimes even the most eminent practical men threw away much time and capital on inventions which, in the end, turned out failures. Sometimes this was due to the fact that, owing to their ignorance of the scientific principles of the case, they hit upon a wrong idea and pertinaciously clung to it, unmoved by constant mishaps which they hoped to overcome by patience and perseverance. But not unfrequently failures occurred, even where the original idea was a good one, which, in the end, was carried to a successful issue. The cause of this may be that the inventor had overlooked some difficulty, apparently unessential, but in effect fatal to success. Or else the proper mechanical means for carrying out the idea were not discovered by the inventor nor the experts consulted by him. I beg leave to illustrate this by a remarkable instance. One of the great problems presented to applied chemistry in the last century, at which many inventors in all industrial countries have been working, was the utilisation of "alkali-waste," that is the residue resulting from the extraction of crude soda by the Leblanc alkali process, which occupies a large space, and which for generations caused an unbearable nuisance for miles around the works by contaminating air and water. The first partial success in this direction was scored in 1861 by Ludwig Mond at Cassel—later on at Widnes, and by Max Schaffner at Aussig. But the endeavours to solve that problem are much older. One of the first patents referring to it was taken out in 1837 by Gossage, one of those great captains of English chemical history whose name I have already cited. Already, at that date, he had conceived the idea of decomposing and utilising the calcium sulphide, which is the principal constituent of alkali-waste, and which, at the same time, is the cause of the nuisance produced by that waste. The idea was to treat the waste with moist carbonic acid, which interacts with the calcium sulphide to form calcium carbonate and hydrogen sulphide. Gossage quite rightly recognised a number of the conditions necessary for realising that reaction, but unfortunately not all of them. To mention only one thing in which he failed: neither Gossage himself, nor anybody else for many years afterwards, hit upon a practicable method of dealing with the dilute hydrogen sulphide formed. After working incessantly at this problem for seventeen years, Gossage believed success within his grasp. Most unfortunately, he was not merely mistaken, but committed a serious financial miscalculation as well. In his over-confidence he launched out into a big speculation by contracting with all alkali manufacturers of Widnes (then the greatest centre of that industry in the whole world) for the treatment of their waste during a number of years. But it soon became manifest that there were unforeseen difficulties not yet overcome. The expense of the treatment, moreover, exceeded the value of the products. Still, Gossage's good faith was recognised on all sides, and all the alkali makers but one released him from his ruinous contract. That single exception, however, proved sufficient to cripple the inventor financially, though his name was even then one of the most honoured in his profession, not merely in England, but also abroad, and though it was common knowledge that he had spent the best years of his life on that thankless task. As late as 1861 he firmly proclaimed his conviction that he was right after all, in a discourse delivered before the British Association. Well, he *was* right, but the missing links in the process were only discovered in 1883 and 1887, and led to the application of that process at all the Leblanc works. This final success is connected with the names of Carl Friedrich Claus and of Alexander Chance.

Just about the time of which I have been speaking, I tried, after absolving my University studies in my native country, Germany, to make my way there in the chemical industry, which, at that time, was certainly in a very backward state. Accordingly, in 1864, I resolved to try my luck in this country, which occupied the first place in this respect as well as in many others. One of my first steps, after arriving in England, was to call at the Royal Institution with a letter from my teacher, the immortal Robert Bunsen, introducing me to the Professor of Chemistry, Edward Frankland, who received me with the utmost kindness, and whose powerful word greatly smoothed my progress. In coming to England for my practical education, I followed the example of many German chemists, of whom I will only quote a few of the most eminent names—Caro, Pauli, Martius, Peter Griess, and Ludwig Mond. The two last-named have permanently associated themselves with this country; whilst the three first-named, as well as many other German chemists who had found a temporary home in England, returned later on to their own country; and these very men have been in the forefront of those to whom is due the remarkable development of German chemical industry, which took place almost at the same time as its political rise, a coincidence which is probably not at all accidental. I myself remained twelve years in England, and only left when called to my professorial chair in Switzerland.

The reason for the sudden and intense blossoming out of the chemical industry in Germany, after being long dormant, and for its firm and healthy rooting in a soil long prepared by the general spread of scientific education, is perfectly clear. Up to that time the German professor, as well as his students, had been frequently held up to ridicule, not merely abroad but at home as well, as idealistic dreamers, unsuited to the wants of real life and to the requirements of trade and manufacture, and in this there was only too much truth, so long as they were not in intimate touch with men of practice. But at last an amalgamation between these two classes of men took place, and was greatly furthered by the World's Exhibitions, chiefly that held in London in 1862, and, moreover, by the very lessons learned by the German students during their stay in England. Without laying aside their scientific armour, they profited by what they had seen of the co-operation of chemistry and engineering, and, generally speaking, of the interaction of science and practical life. Within a very few years there arose those enormous establishments at Ludwigshafen, Hochst, Elberfeld, Berlin, Darmstadt, and elsewhere, which are conducted on a scientific basis, but with the most extensive utilisation of all the attainments of manufacturing experience. Several of these have now a staff of a couple of hundred chemists and of dozens of fully-trained engineers. But although at present Germany certainly holds the foremost position in many branches of chemical industry, it would be unfair to award to her the only palm for progress in this branch of human work. Austria, France, Switzerland, and Belgium have all made immense strides in that direction; of America we shall speak anon. And what of Great Britain? Well, she has certainly not stood still, and she is still one of the greatest homes of industrial chemistry, but one cannot blind oneself to the fact that her progress in this line has not been quite so rapid as that of the other countries just named, to say nothing of the United States, whose chemical industry was hardly in existence at the beginning of that new epoch, but which now is second to none but England and Germany. To some extent the comparative slowness of development in this country is not absolute, but merely relative. It is clear that those who are already well ahead cannot, within a given time, cover as much ground as those who start late, since there is so much less leeway to make up; hence the quicker progress made by the late starters does not mean any real superiority, provided always that the former class are not actually outstripped in the race. The question whether this has really come to pass in this or in that field of chemical industry in the struggle for life between the English chemical manufacturers and their Continental and American rivals, is too wide and too

delicate a topic to be touched upon now. But so much you will allow me to say—if we confine ourselves to a comparison of English and German chemical industries, I have surely laid sufficient emphasis upon the fact that the Germans have immensely profited from the English in the matter of practical manipulation and in the co-operation between chemists and engineers. Why should not the English then turn the tables on the Germans, and profit, in their turn, by giving a wider scope to the scientific treatment of industrial problems in their factories than has hitherto been the rule? Seeing that in pure science the people of Great Britain have never lagged behind *any* other nation, and that, on the contrary, the land of Newton and Faraday has been a beacon to all others at more than one epoch, there is absolutely no valid reason why she should now, or at any other time, be behind any other in the combination of science with practice.

Before turning to another chapter, I beg leave to mention a very good instance of the way in which Englishmen have understood how to combine engineering with chemical manufacture. I have already spoken of the introduction into this country of the Leblanc process for the manufacture of one of the most important chemical products, carbonate of soda, or "alkali," in the parlance of trade. This process came over from France; but it had not been long employed in England before it was thoroughly modified in all particulars, and thus rendered more efficient and more remunerative. In no instance have the excellence of English methods, and their superiority over those used at that time on the Continent, been better proved than here. My own treatise on "Sulphuric Acid and Alkali" is, in its technological part, based mainly on what I had learned and practised during the twelve years of my residence in this country; and if that treatise has met with a favourable reception, as having proved useful to both British and non-British alkali makers, it is due to the circumstance just mentioned. But those methods, worked out during the second and third quarter of the last century, have had their day. A new process came up, which sapped the economical foundation of the Leblanc process. The history of this, the ammonia-soda process, has, strange to say, been directly contrary to so many others. It was invented by two Englishmen, Dyar and Hemming, who patented it in 1838, and who established the (very simple) chemical part of it in such manner that nothing really essential has been added since their time. But Dyar and Hemming did not succeed in the *practical* application of their invention, nor did their numerous successors meet with any better fortune, either in this country or elsewhere. It was reserved to a Belgian engineer, Ernest Solvay, to find the first economical solution of that problem, and this he achieved only after many years of patient work, and after sacrificing nearly all his means. Once he had gained his point, however, the economical superiority of the ammonia over the Leblanc process soon became evident. This was brought home to English manufacturers by the success of the firm of Brunner, Mond, and Co., which had acquired Solvay's English patent rights. The Leblanc process, and the enormous sums of money invested in it, seemed even then doomed to speedy extinction. But for a time, at least, this calamity was averted by the perseverance with which the British alkali makers kept making improvements in the Leblanc process, all calculated to cheapen it and lessen the nuisance connected with it. I cannot go into details on this point, but I wish to mention at least two things. One of these I have already spoken of in another connection—I mean the recovery of the sulphur from the alkali waste, where it had been the cause of an intolerable nuisance, and which now became the source of considerable profit. The second point is the substitution of machinery for manual labour in all stages of the process. It is only by means of these, along with a number of other improvements, that it has been made possible for the Leblanc process to survive to a certain extent. How much longer that is likely to continue I will not pause to speculate on. The prolongation of its life is due to the fact that in the first stage of the process an important acid is produced, which is not furnished by the ammonia process, viz., hydrochloric acid. Most of this is immediately converted into chlorine, which gas is used up for preparing very important articles of trade, viz., bleaching powder, bleach liquors, and chlorates. Of these, bleaching powder is a British invention, made by the Glasgow chemist, Tennant; but, apart from this, the manufacture of chlorine and of all chlorine products has been put on its practical basis almost entirely by English inventors, and has been developed more extensively in this country than anywhere else in the world. The processes worked out by Tennant and Dunlop at Glasgow, as well as by a host of others—amongst whom the names of Weldon and Deacon, in Lancashire, stand out prominently—have been copied for generations all the world over. The manufacture of chlorine products, which is not possible in the ammonia-soda process, has naturally given a new lease of life to the Leblanc process, at least in its first stage, which is the manufacture of salt-cake and hydrochloric acid. But, on the other hand, this last entrenchment of the Leblanc process is being vigorously assaulted from another quarter—by the electrolytic processes, which split up the alkaline chlorides directly, and in the simplest possible manner, into free chlorine and caustic alkali.

We are, in these days, so much accustomed to deal with electricity in its innumerable applications, that we are apt to forget how recent is the introduction of that force of Nature into practical chemistry. One of the finest heads among English alkali makers, whose grasp of the principles of science far surpassed that of most ordinary technical chemists, Dr. Ferdinand Hurter, pronounced himself, as late as 1888, decidedly against the commercial possibility of introducing electricity as an agent for manufacturing the cheaper class of chemicals. But within a very few years of that date the contrary had become an established and well-known fact, even in his own domain of alkali. True, in hardly any field have there been more failures to translate the results of science into economical manufacturing processes than in that of electricity; and even now it is only quite exceptionally that, wherever the electric current has to be produced by means of *steam*, electro-chemical methods can compete with the older ones for the manufacture of what is called "heavy chemicals." This is easily understood when we remember that about 90 per cent of the heat-value of coal, or its equivalent of energy, is lost in the circuitous routes of steam boiler, steam engine, and dynamo. But there are several ways in which the problem of obtaining cheaper electricity is being grappled with; and, if most of these have to be dismissed for the present, as belonging to the "music of the future," we have at least one which is a hard fact, and that is the generation of electricity by water-power. Unfortunately, in the British Isles the amount of available water-power is very limited in comparison with many other countries. It is a curious coincidence that those two European countries which are the greatest producers of coal, Great Britain and Germany, should be less favoured by Nature in respect of water-power than other countries which possess little or no stores of mineral fuel, as Sweden, Norway, Switzerland, France, Italy, and Spain. A very different condition of affairs obtains in the United States, where we find the greatest coal-fields combined with the greatest amount of water-power existing in any civilised country. It is impossible to shut one's eyes to the fact that the day will inevitably come when the coal-fields will be so far exhausted that all those industries which consume large amounts of mechanical energy will be forced to emigrate to countries where water-power is abundant.

No other substitute has, as yet, been found for generating force, and, indirectly, electricity. True, the energy given out by the descent of water in rivers is but a small fraction of that which is radiated upon the earth from

the sun, or of that which is developed by the play of the tides and the force of the wind, but no way has yet been found of utilising these other sources of energy, except to the slenderest extent. The harnessing of these natural agents belongs, so far as we can see, to the class of problems which will hardly be solved by our own generation, whatever developments the remoter future may bring. But of the water-power existing on this planet there is a large proportion which has never yet been touched, and this, as well as the water-power which has been already forced into the bonds of man, runs on for ever. This is, of course, an incalculable advantage over coal, which, by its use as fuel, is dissipated into the atmosphere in the shape of carbon dioxide, and thus altogether destroyed as a source of energy, since from carbon dioxide fresh fuel can only be generated by the intervention of solar energy, and this takes place at such a very slow rate that it cannot be taken into account in our economical consideration.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, March 21st, 1907.

Sir Henry E. Roscoe, F.R.S., Past President, in the Chair.

Messrs. W. J. Bowis, L. M. Deane, E. W. L. Foxall, W. Godden, C. M. W. Grieb, and J. L. Simonsen were formally admitted Fellows of the Society.

Before commencing the business of the Society, Sir Henry Roscoe said that the Fellows would have learnt with great regret of the loss which their science, and especially French chemistry, had to deplore in the sudden and pathetic death of Marcelin Berthelot. This was not the occasion to dwell upon the important work which he had accomplished or on his noble character. These considerations would doubtless be fully dealt with hereafter. All that the Fellows of the Society now could do was to express their grief at his death and their sympathy with his family.

The Chairman also alluded with feeling to the death of their old Fellow, Prof. Warington.

Certificates were read for the first time in favour of Messrs. Kenneth Somerville Caldwell, B.Sc., Ph.D., St. Bartholomew's Hospital, E.C.; John Jacob Fox, 6, Alkham Road, Stamford Hill, N.; Joseph Henry Hall, B.Sc., 84, The Grove, Wandsworth, S.W.; Thomas Featherstone Harvey, 84, Henry Road, West Bridgford, Nottingham; Edward Houghton, Glenhyrst, 106, Saltergate, Chesterfield; Carl Lewis, P.O. Box 36, Johannesburg, S. Africa; Herbert Victor Mitchell, 26, Brookfield Avenue, Walthamstow; Capt. George Colleymore Sturrock, R.A., Arubankad, Nilgiris, India; Sam Mortimer Sutcliffe, 4, Clive Place, Bradford.

Of the following papers, those marked * were read:—

*60. "*Synthesis of Polypeptides.*" By Emil Fischer.

Continuing his work on the synthesis of polypeptides the author has prepared an octadecapeptide containing fifteen glycocoll and three *l*-leucine residues.

Pentaglycylglycine was allowed to react with *d*-bromo-*iso*capronyldiglycylglycyl chloride, and the product so obtained was treated with ammonia with formation of *l*-leucyloctaglycylglycine. By a repetition of this series of reactions the octadecapeptide, *l*-leucyltriglycyl-*l*-leucyl-triglycyl-*l*-leucyloctaglycylglycine,—

$$NH_2\cdot CH(C_4H_9)\cdot CO[NH\cdot CH_2\cdot CO]_3\cdot NH\cdot CH(C_4H_9)\cdot CO[NH\cdot CH_2\cdot CO]_3\cdot NH\cdot CH(C_4H_9)\cdot CO[NH\cdot CH_2\cdot CO]_8\cdot NH\cdot CH_2\cdot CO_2H,$$

has been synthesised.

Discussion.

The Chairman said that he only voiced the feelings of the Society when he expressed his admiration for the interesting and remarkable lecture to which they had all listened with pleasure. In reciprocating to the full the words which had fallen from Professor Armstrong's lips as to the wonderful character of the researches which Professor Fischer had described, he remarked that whilst they looked upon these researches as typical of the great strides made in German chemical science, he ventured to think that Professor Fischer would agree with him when he said that he believed that the work done by the Fellows of our Chemical Society at the present time would bear not unfavourable comparison, both as to quality and quantity, with that which is now being carried out in Germany. Indeed, when he looked back to the early years of the Society, as his friend Sir William Perkin and he could do, and remembered the progress which it had made, the activity which the Fellows of the Society had shown in recent years in advancing the progress of their science struck him as most remarkable, and this in spite of the many drawbacks which have often been said to discourage original research in England. We could not, indeed, vie with Germany in the special department of research which had just been laid before the Society, and this for a very simple reason, that there was only one Emil Fischer.

*61. "*Organic Derivatives of Silicon.* Part III. dl-*Benzylmethylethylpropylsilicane and Experiments on the Resolution of its Sulphonic Derivative,*" By Frederic Stanley Kipping.

dl-Benzylmethylethylpropylsilicane, SiMeEtPrBz (*Proc.*, 1905, xxi., 65), is sulphonated by sulphuric acid at about 130°, yielding a mixture of acids of which two were isolated in the form of their *l*-menthylamine salts.

Analyses of one of these salts seem to show that it is derived from *benzylethylpropylsilicolsulphonic acid*, and has the formula $EtPrSi(OH)\cdot CH_2\cdot C_6H_4\cdot SO_3H, C_{10}H_{21}N$, but as it is formed in small amount only it has not been very thoroughly investigated; the formation of such an acid from the silicohydrocarbon would necessitate the hydrolytic separation of the methyl group in a manner similar to that in which the phenyl group is displaced on sulphonating phenylbenzylethylpropylsilicane (*Trans.*, 1907, xci., 224). The salt crystallises in prisms, and melts at 210—212°.

The second *l*-menthylamine salt isolated from the mixture is derived from dl-*benzylmethylethylpropylsilicanesulphonic acid*, and has the formula $SiMeEtPr\cdot CH_2\cdot C_6H_4\cdot SO_3H, C_{10}H_{21}N$. This compound is much more easily obtained from the product of the sulphonation of benzylmethylethylpropylsilicane with chlorosulphonic acid. It crystallises best ($+2H_2O$) from wet, light petroleum, and when dehydrated melts at 121—123°.

The *l-menthylamine*, *quinine*, *cinchonidine*, *cinchonine*, *narcotine*, and several other salts of this *dl*-silicanesulphonic acid have been crystallised fractionally under various conditions, but without the faintest indication of a resolution of the acid having been observed.

*62. "*The Reduction of Carbon Dioxide to Formaldehyde in Aqueous Solution.*" By Henry John Horstman Fenton.

The author finds that by the action of metallic magnesium, under appropriate conditions, on an aqueous solution of carbon dioxide, recognisable quantities of formaldehyde can be obtained, and that the amounts are considerably increased if weak bases, such as ammonia, aniline, phenylhydrazine, or aluminium hydroxide are also present.

Further, it is found that formic acid may readily be reduced, in part at any rate, to formaldehyde by the action of magnesium, so that the desired reduction of carbon dioxide may be effected also in two stages, with formic acid as the intermediate product.

*63. "*The Mechanism of the Rusting of Iron.*" By Gerald Tattersall Moody.

The author has previously shown that the presence of acid is essential for rusting to occur. The following experiments enables the exact mechanism of the production of rust to be visualised :—In the bottom of a glass cylinder are placed some rods of bright iron such as French nails. These are only loosely packed, for the most part heads upward, and are so arranged that some of them remain vertical whilst others occupy inclined positions. Recently boiled distilled water is then poured into the cylinder until it stands about one and a-half inches above the heads of the nails. The mouth of the cylinder is loosely closed with a sheet of paper so as to exclude dust and at the same time to allow free access of air to the water, whereby carbonic acid and oxygen are absorbed. In the course of twenty-four hours the water shows signs of becoming turbid, and shortly afterwards a copious separation of brown particles from the solution is distinctly observed. These brown particles are continuously formed, and gradually settle on the heads of the nails, and on the upper parts only of those nails which are inclined. The under parts of the inclined nails and the vertical nails remain bright, no general corrosion of the surfaces being observable. At the end of seven days a thick layer of hydrated ferric oxide has collected on the upper surfaces of the nails, and also on the bottom of the cylinder. If a sheet of hardened filter-paper or some other material which allows of diffusion be placed in a horizontal position immediately over the nails at the beginning of the experiment, the rust which separates from the solution above it gradually collects on its upper surface and eventually forms a thick layer.

The separation of the rust from the water and its non-formation on the surface of the iron can be explained only as an oxidation of ferrous iron actually in solution. This is in strict accordance with the experimental evidence already advanced, and shows that, in rusting, iron is first dissolved with formation of ferrous salt which subsequently oxidises to rust.

Discussion.

The Chairman remarked that all those present must be much struck by the extremely simple and convincing experiments which the author had described, showing that the first step towards the rusting of iron was that the metal entered into solution in the liquid. He ventured to doubt, however, whether the author had even now got to the bottom of the subject, simple though it apparently was, because he had not explained how the solution of the metal was effected, whether this solution occurred in presence of carbonic acid only or whether in its absence.

Dr. Moody said that he had already described experiments which showed conclusively that the presence of acid is essential for rusting to occur (*Trans.*, 1906, lxxxix., 720). In absence of acid, pure iron was allowed to remain in contact with water and oxygen for several weeks without even one speck of rust being formed, and without the iron undergoing any change either in appearance or in weight. It was specially noteworthy that when pure iron was placed in a dilute solution of hydrogen peroxide free from acid, no oxidation or other change in the iron occurred, although oxygen was freely evolved from every part of the immersed metal. In this way the indifference of iron towards oxygen in presence of water could be easily and conclusively demonstrated. In the experiment he had shown the Society that evening, the iron was undoubtedly dissolved by carbonic acid, and the ferrous bicarbonate thus formed was converted into rust by oxygen, which, simultaneously with the carbonic acid, diffused into the solution from the atmosphere.

*64. "*Influence of Non-electrolytes and Electrolytes on the Solubility of Sparingly Soluble Gases in Water. The Question of Hydrates in Solution.*" By James Charles Philip.

It is suggested that the influence of non-electrolytes and electrolytes on the solubility of gases may be adequately interpreted by reference to two factors. Firstly, it may be supposed that the non-electrolyte or electrolyte takes no part in the absorption, and accordingly the standard absorbing volume should be not 1 cc. or 1 litre of the solution, but that volume of the solution which contains 1 grm. or 1000 grms. of the pure solvent. Secondly, hydration of the non-electrolyte or electrolyte may occur, and it may be supposed that the solvent which is thus attached is no longer free to absorb the gas. These suggestions have been tested with satisfactory results by reference to available experimental data, and the values found for the average molecular hydration of dissolved salts are in fair agreement with the values reached by other and widely different methods.

Discussion.

Sir William Ramsay asked whether it must not be held that both the solvent and the solute take part in dissolving a gas. For example, a solution of sugar in water is a mixture of liquid sugar and liquid water, and it might be supposed that hydrogen would dissolve in both water and in sugar according to its solubility in each and to their relative amount.

Mr. R. J. Caldwell drew attention to the fact that Euler and others had recognised that the absorption coefficients of the permanent gases, as well as the solubility of ethyl acetate, are equally affected by the presence of dissolved solids. It had long been clear to him that this regularity could be accounted for by assuming that a diminution of the amount of free water was caused by the formation of hydrates of the dissolved substance; most of the material had been collected for a communication on the subject. From the very accurate values given by Winkler for the solubility of oxygen, making due allowance for the fact that Winkler used volume-normal solutions, he had calculated that the average degree of hydration of calcium chloride in a solution of grm.-molecular strength (weight-normal) was in the ratio $CaCl_2 : 21H_2O$. This result is in accord with the value $CaCl_2 : 22H_2O$ he had obtained by the sugar inversion method; in the case of other salts, a like agreement had been found. It was difficult to see how such agreements could be reconciled with the ionic dissociation hypothesis.

Dr. Philip said that it was certainly possible that hydrogen was soluble to some extent in chloral hydrate and sucrose, but it appeared unlikely in view of the fact that the average molecular hydration calculated on the basis of the two factors suggested in the paper agreed with values obtained by methods into which the question of solubility of hydrogen in these substances could not possibly enter.

The view that hydrates exist in aqueous solutions of electrolytes was not inconsistent with a general adherence to the ionic theory.

*65. "*A New Class of Organo-metallic Compounds.* (Preliminary Notice). *Trimethylplatinimethyl Hydroxide and its Salts.*" By William Jackson Pope and Stanley John Peachy.

No alkyl compounds of metals belonging to Group 8 of the Periodic Table have hitherto been described. The authors find that the chlorides, or in some cases the oxides, of iron, cobalt, nickel, ruthenium, rhodium, palladium, osmium, iridium, and platinum, belonging to Group 8, and of gold, belonging to Group 1, react vigorously with magnesium methyl iodide; they desire to reserve the study of the action of Grignard's reagent on compounds of the metals named.

Trimethylplatinimethyl iodide, $(CH_3)_3PtI$, is formed by the action of platinic chloride dissolved in ether on magnesium methyl iodide in ethereal benzene solution; after treating with water and extracting with benzene, the benzene solution yields the new compound on evaporation. It crystallises in straw-yellow plates, is not volatile, and decomposes on heating with slight explosion; it is very stable towards reagents, and is not attacked in the cold

by strong caustic alkalis, alkali sulphides, or by nitric, hydrochloric, and sulphuric acids. It is not further acted on by magnesium methyl iodide. On boiling for several hours with silver hydroxide in a moist mixture of benzene and acetone, it is converted into *trimethylplatinimethyl hydroxide*, $(CH_3)_3Pt{\cdot}OH$; this substance is insoluble in water, gives no alkaline reaction with litmus, and crystallises in colourless rhombic dodecahedra belonging to the cubic system.

Trimethylplatinimethyl nitrate, $(CH_3)_3Pt{\cdot}NO_3$, obtained by dissolving the hydroxide in nitric acid, crystallises in colourless plates, and is freely soluble in water. On adding an alkali chloride to its aqueous solution, *trimethylplatinimethyl chloride*, $(CH_3)_3PtCl$, is precipitated; this salt crystallises from chloroform in colourless rhombic dodecahedra belonging to the cubic system. In a similar manner a number of other salts have been prepared, including the *bromide* and the *cyanide*; the latter is hydrolysed on heating with caustic potash with evolution of ammonia.

DISCUSSION.

The CHAIRMAN congratulated the authors on having opened out an entirely new branch of investigation which might indeed be said to be a wonderful "find."

(To be continued).

FARADAY SOCIETY.

Ordinary Meeting, March 19th, 1907.

Dr. T. MARTIN LOWRY in the Chair.

The following nominations for the Officers and Council to be elected at the forthcoming Annual General Meeting were announced:—

President—Sir William Perkin, F.R.S.

Vice-Presidents—G. T. Beilby, F.R.S.; R. A. Hadfield; Prof. W. Hittorf, Geh. Reg.-Rat.; Sir William Huggins, O.M., K.C.B., F.R.S; Prof. A. K. Huntington; Prof. A. Schuster, F.R.S.; Prof. J. J. Thomson, F.R.S.

Treasurer—F. Mollwo Perkin, Ph.D.

Council—A. C. Claudet, M.I.M.M.; S. Z. de Ferranti, M.I.E,E.; F. W. Harbord, F.I.C.; R, S. Hutton, D.Sc.; T. M. Lowry, D.Sc.; W. M. Morrison, M.Inst.C.E.; James Swinburne, F.R.S.; N. T. M. Wilsmore, M.Sc.; Prof. E. Wilson; J. L. F. Nogel, M.I.E.E.

A paper by Mr. H. NUTTON and Mr. H. D. LAW on "*The Potential of Hydrogen liberated from Metallic Surfaces*," was read in abstract by Mr. NUTTON:

The paper is chiefly concerned with the chemical reducing power of hydrogen when liberated from the surface of various metallic electrodes, and also the retarding action caused by the presence of small quantities of metallic salts. The metals are arranged in the following order: mercury, lead, cadmium, tin, silver, bismuth, gold, nickel, platinum (black), the first-mentioned metal being the most capable of bringing about the reduction of a compound not readily attacked; platinised platinum, on the other hand, possesses this property in the lowest degree. Zinc as a reducer behaves in a very irregular manner; both copper and platinum (black) show a remarkable activity in the reduction of aromatic aldehydes, and iron and aluminium are variable. It was hoped by a careful study of the electrode potentials that it might be possible to differentiate between the purely chemical changes and those which were due to physical causes.

The E.M.F. between the cathode and the hydrogen electrode was measured on the Clark Fisher "compensating potentiometer" reading to one-tenth millivolt. The current was read on a standard millivoltmeter shunted to read milliamperes. The cathode solution was contained in a carefully cleaned porous pot fitted with a rubber stopper having three outlets, the cathode being fixed in one by means of sealing wax, and thus being easily removed. Another hole in the stopper contained a capillary tube connected with the hydrogen electrode which was arranged to be close to the metallic cathode. When possible the cathodes were bent in the form of a cylinder and had a superficial area of 20 sq. centimetres on one side. The conclusions arrived at are briefly as follows:—The supertension of one and the same metal is not a fixed quantity, being influenced by the physical and chemical nature of the surface. Film formations have also a large influence. Chemical reactions are greatly increased by raising the supertension. The nature of the electrolyte can completely change the nature of the chemical reaction without any corresponding change in the supertension. The supertension gives but a small indication of catalytic action. The fall of potential on the addition of a depolariser is only a rough guide to the nature of the reduction which is taking place.

Mr. JOHN RHODIN drew attention to the effect of barometric pressure on the liberation of hydrogen on the cathode. The question of the potential of hydrogen had an important bearing on the dissolution velocity of metals, and here pressure had a very marked influence.

Mr. N. T. M. WILSMORE said that the authors had shown that the connection between supertension and reducing power that had been claimed by Nernst did not really exist.

Mr. H. D. LAW thought that, in view of the enormous pressure of the hydrogen on the cathode, any change of barometric pressure was not likely to be of effect. He inclined to the view that many metals existed in two forms, one with a high and one with a low supertension. The result of the paper was to show that supertension was a very variable quantity, and much more work remained to be done on the subject.

Mr. N. T. M. WILSMORE then read a paper, written conjointly with Mr. F. M. G. JOHNSON, on "*Electrode Potentials in Liquid Ammonia.*"

The measurements of electrode potentials in liquid ammonia were undertaken with a view to the determination of the free energy of formation of a series of metallic salts, and thereby to compare the relative affinities of the corresponding metallic elements under conditions differing as much as possible from those obtaining in the case of measurements in aqueous solutions. To this end the electrode potentials of the metals against solutions of their salts of known strength were measured against a standard electrode (cadmium in a saturated solution of cadmium nitrate). The results are given in the paper in tabular form.

In order to obtain values for the single electrode potentials, the "standard" electrode employed was measured directly against the *n*/10 calomel electrode, and the P.D. thus found was used to calculate the E.M.F.'s tabulated in the paper. (See accompanying table).

For comparison, the corresponding "electrolytic potentials" for aqueous solutions are added in the tables. Owing to lack of conductivity data, however, it was not possible to reduce the electrode potentials in ammonia to electrolytic potentials referred to unit ionic concentration. The research is thus, in a sense, incomplete.

Mr. JOHN G. A. RHODIN then read a paper entitled "*The Impedance of Solutes in Solvents as manifested by Osmotic Pressure.*"

The author's object is to substitute for the theory of van't Hoff, the main objection to which, in his opinion, is the direction of pressure, a theory which regards the solvent—and not the solute—as the source of the energy manifested in osmotic pressure experiments. The presence of a solute in a solvent diminishes the potential energy of the latter; there is, therefore, a flow of energy across the semi-permeable membrane from the solvent to the solution inside the membrane. The "osmotic pressure" is thus a potential pressure, made actual by the transformation of the excessive potential energy of the solvent

Metal.	Electrolyte.	E.M.F. in liquid NH_3.	E.P. in aqueous solution.	Difference. For *n*/10.	Difference. For *n*/100.
K	KI *n*/10	+2·64	+3·20	−0·56	
Na	NaCl *n*/10..	+2·63	+2·82	−0·19	
Na	$NaNO_3$ *n*/10	+2·61	+2·82	−0·21	
Ca	$Ca(NO_3)_2,4H_2O$ *n*/10	+2·53	+2·56	−0·03	
Mg	MgI_2 *n*/100	+2·31	+2·54 +1·49		−0·23 +0·82
NH_4	NH_4NO_3 *n*/10	+1·96			
Zn	$Zn(NO_3)_2,6H_2O$ *n*/100	+1·424	+0·770		+0·65
Zn	$Zn(NO_3)_2,6H_2O$ *n*/10	+1·401	+0·770	+0·63	
Cd	$Cd(NO_3)_2,4H_2O$ *n*/100	+1·134	+0·420		0·71
Cd	$Cd(NO_3)_2,4H_2O$ *n*/10	+1·095	+0·420	0·68	
Ni	$Ni(NO_3)_2,6H_2O$ *n*/10	+0·548	+0·228	0·32	
Pb	$Pb(NO_3)_2$ *n*/100	+0·553	+0·148		0·41
Pb	$Pb(NO_3)_2$ *n*/10	+0·533	+0·148	0·39	
Cu	$Cu(NO_3)_2,3H_2O$ *n*/100	+0·47	−0·329		0·80
Cu	$Cu(NO_3)_2,3H_2O$ *n*/10	+0·35	−0·329	0·68	
Cu	$Cu(NO_3)_2,3H_2O$ *n*/1	+0·37	−0·329		
Hg	HgI_2 *n*/100	+0·181	−0·750		0·93
Hg	HgI_2 *n*/10	+0·153	−0·750	0·90	
Ag	AgI *n*/100	+0·221	−0·771		0·99
Ag	AgI *n*/10	+0·163	−0·771	0·93	
Ag	$AgNO_3$ *n*/100	+0·116	−0·771		0·89
Ag	$AgNO_3$ *n*/10	+0·085	−0·771	0·86	

on the one side of the semi-permeable membrane, by absorption of exterior heat energy. Hence the time required is a function of the alteration of the volume of the solution on the other side of the membrane, and accurate and speedy methods of mensuration must involve the keeping of this volume as nearly constant as possible.

To explain the action of semi-permeable membranes, the author imagines these—and colloids generally—to be composed of radial filaments, emanating from a common centre. The structure is coarse compared with that of the solvent, but the cilia impede the motion of the molecules of the latter. In an osmotic experiment the stronger bombardment on the solvent side polarises the filaments into cones, and a kind of Bunsen valve is thus produced.

Dr. T. M. LOWRY said the "sieve" theory of the membrane, which the author seemed to advocate, was now generally abandoned, the view that the action was one of selective solubility being substituted.

Dr. T. SLATER PRICE communicated Part II. of a paper entitled "*The Electrolytic Deposition of Zinc, using Rotating Electrodes.*"

The effect of the addition of various electrolytes on the electrolytic deposition of zinc, using a rotating cathode and the apparatus described in the previous paper, has been investigated. In all the experiments the cathode was silvered before the zinc was deposited. Excellent results were obtained, using 2 grms. of sodium sulphate and 1 grm. of sodium acetate for each grm. of crystallised zinc sulphate, the addition of free acetic acid being unnecessary. The number of revolutions per minute of the cathode was 600 to 700, and the time of deposition was fourteen minutes. Satisfactory, but slightly high results, were also obtained when the following electrolytes were used: (1) 2 to 5 cc. concentrated ammonia, (2) 4 grms. caustic soda, (3) 3 grms. sodium acetate. The amount of zinc sulphate taken for each determination was 1 grm., and the solutions were electrolysed in the cold; if they were heated to boiling-point before the electrolysis was commenced the results were unsatisfactory. Neither ammonium acetate nor sodium sulphate is a satisfactory electrolyte.

Unless the cathode was coated with either silver or copper before the zinc was deposited high results were obtained, and it was difficult to get all the zinc out of the solution. When a rotating cathode is used, the zinc does not alloy with the platinum if deposited directly on to it (*cf.* Medway, *Amer. Journ. Sci.*, 1904, [4], xviii., 56).

The modification of Kollock and Smith's method (rotating anode and mercury cathode), which was suggested in the first paper, has not been found to be as satisfactory as at first trial it seemed to be. Considerable experience and very careful manipulation are required before good results can be obtained.

A thorough examination of Kollock and Smith's own method has shown it to give low results for zinc, both zinc and mercury being lost in the washing to which the amalgam is subjected; a little zinc dissolves as hydrate in the wash-water, and some mercury is either mechanically carried away or else chemically dissolved.

NOTICES OF BOOKS.

Photography for Students of Physics and Chemistry. By LOUIS DERR, M.A., S.B. New York: The Macmillan Company. London: Macmillan and Co., Ltd. 1906.

THIS volume is based upon the author's lectures on Photography delivered at the Massachusetts Institute of Technology, and it occupies a unique position among handbooks dealing with the subject. It is in no sense a complete treatise for the use of advanced students, nor is it a popular account of photographic manipulation, designed for the worker without scientific knowledge, but it attempts to describe the processes with special reference to the principles involved, and to explain the details for the benefit of those who have some acquaintance with the elements of physics and chemistry, and who wish to understand the phenomena which lie at the basis of the operations. The earlier chapters discuss elementary optics and explain the function of the lens, methods of testing lenses, and aberration. The diaphragm and its use are next considered, and a chapter is devoted to the camera and its accessories. The chemistry of the process is then taken up and the reactions involved in development, intensification, and reduction are fully and carefully explained. The making of lantern slides is also described, and the book ends with a short and perhaps somewhat inadequate account of colour photography, which in a book of this kind might with advantage have been treated in rather greater detail.

Handbuch der gesammten Thonwaaren-industrie. ("Handbook of the Clay Industries.") By Bruno Kerl. Third Edition, prepared by Eduard Cramer and Dr. Hermann Hecht. Braunschweig: Friedrich Vieweg und Sohn. 1907.

This comprehensive work is intended for the use both of technical students and of specialists, and all those who have any connection with the clay industries, and who wish to have at their disposal the latest information concerning practically any branch of these industries, will find it a valuable possession. As in the earlier editions, the first part deals with the general principles involved, and the second treats of the manufacture of various articles and products in detail. The third edition has been enlarged to more than twice the size of the original, and contains double the number of illustrations, and will rank as one of the most thorough and complete text-books extant on the subject.

La Moderna Teoria dei Fenomeni Fisici. ("Modern Theory of Physical Phenomena.") Third Edition. By Augusto Righi. Bologna: Ditta Nicola Zanichelli. 1907.

Although it is not very long since the second edition of Prof. Righi's interesting work appeared, so much fundamental work has been done with regard to the phenomena of radio-activity, and recent theoretical developments have been of such great importance, that the third edition contains a great deal of new matter. A chapter is added on the atomic transformations of the radio-active bodies, and the bibliography has been brought down to the year 1906. As an elementary discussion of modern theories this book is excellent; it is written in popular style, and yet is accurate in every respect, and both the general reader and the student with an elemeutary knowledge of physics and chemistry will find that it gives an interesting and clear account of the principal facts upon which the electron theory is based.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 11, March 18, 1907.

A Property of Platinum Amalgam.—H. Moissan.—Pure mercury shaken with water, as is well known, forms no mixture with it; but an amalgam of mercury and platinum after being shaken for a few seconds with water forms a semi-solid mass, of the consistency of butter, and of about five times the volume of the original amalgam. This emulsion is stable, and exhibits no change after standing for a year; it resists the action of heat and of cold. Microscopic examination shows droplets of water disseminated through the mass, giving it a cellular appearance. Copper, silver, and gold amalgams do not form emulsions with water. Platinum amalgam forms emulsions with other liquids also, such as sulphuric acid, solutions of ammonia, ammonium chloride, sodium chloride, glycerin, acetone, alcohol, ether, carbon tetrachloride, chloroform. All are stable. Emulsification is also produced when mercury is shaken with water to which a 10 per cent solution of platinum chloride has been added.

Alloys of Nickel and Tin.—Em. Vigouroux.—The author gives some results of his researches upon pure bronzes, in which the red copper has been replaced by white copper or nickel, and in all cases the alloys contain more than 66 per cent tin. The analyses of three operations give as the composition of the alloys 73·64, 83·65, and 92·71 per cent tin respectively, the rest being represented by nickel in each case. They all possess the usual non-magnetic character.

The Arsenites and Arseniates of Rubidium.—A. Bouchonnet.—The author describes the preparation of certain oxygen compounds of arsenic with rubidium and cæsium hitherto not made known. 1. *Rubidium Meta-arsenite*, AsO_2Rb.—Obtained by dissolving in water the molecular weights of arsenious anhydride and rubidium carbonate, $As_2O_3 + Rb_2CO_3 \quad 2AsO_2Rb + CO_2 + H_2O$. This is a syrupy mass which can be dehydrated on a porous plate *in vacuo* to a white amorphous powder. It possesses the general characteristics of the arsenites, reducing potassium permanganate and chromic acid. 2. *The Monobasic Arseniate*, AsO_4RbH_2.—Obtained (*a*) by melting equal parts of arsenious anhydride and rubidium nitrate, dissolving in water, filtering, and evaporating *in vacuo*; (*b*) by neutralising an aqueous solution of rubidium carbonate with arsenic acid, using methyl-orange as indicator, then crystallising as before. 3. *The Dibasic Arseniate*, AsO_4Rb_2H.—Prepared by weighing out of contact with the air 5 grms. of pure rubidium hydrate and 11 grms. of the monobasic arseniate, weights calculated from the formula $AsO_4RbH_2 + RbOH = AsO_4Rb_2H + H_2O$. These are mixed in aqueous solution and evaporated *in vacuo*. The crystals, consisting of white plates, lose their water of crystallisation, changing to the pyroarseniate, $As_2O_7Rb_4$, under the action of heat. On further heating the latter changes to the meta-arseniate, AsO_3Rb. 4. *The Tribasic Arseniate*, AsO_4Rb_3.—Obtained by neutralising an aqueous solution of rubidium hydrate by arsenic acid. Trirubidic arseniate crystallises with difficulty. It is necessary to evaporate in the presence of caustic potash, placing the moist crystals finally on a porous plate and leaving them for several days in presence of phosphoric anhydride.

Berichte der Deutschen Chemischen Gesellschaft. Vol. xl., No. 2, 1907.

Pentaphenyl-ethane and Hexaphenyl-ethane.—A. E. Tschitschibabin.—The author has shown that in an atmosphere of carbon dioxide pentaphenyl-ethane melts at 178—179°. Decomposition always occurs at the melting-point. In air it possesses no sharp melting-point, but gradually decomposes on warming, oxidation taking place. At high temperatures, both as such and also in nitrobenzene solution, it absorbs the oxygen of the air energetically. On warming it splits up into *sym*-tetraphenyl-ethane and hexaphenyl-ethane (triphenyl methyl), and the latter (and in certain circumstances the former also) is then oxidised by the oxygen of the atmosphere. When warmed with hydrochloric acid in benzene solution in absence of air, at 150° the substance is converted into *sym*-tetraphenyl-ethane, triphenyl-methane, and triphenylchlor-methane, and is thus very labile. These experiments show that triphenylmethyl is probably hexaphenyl-ethane, Schmidlin's "hexaphenyl-ethane" is possibly a somewhat impure tetraphenyl-methane, the result of the condensation $(C_6H_5)_3CCl + C_6H_6 = (C_6H_5)_4C + HCl$.

Detection of Salts of Sulphurous Acid in presence of Thiosulphates and Thionates.—E. Votocek.—The author's method is based upon the observation that solutions of normal sulphurous acid salts react almost instantaneously with dilute solutions of many dye-stuffs of the triphenylmethane series (fuchsine, malachite-green, &c.). Decolorisation ensues immediately on mixing the solutions, for sulphites of the colour bases are formed which are practically colourless in dilute solution. If a sufficient amount of aldehyde is added to the colourless solution (preferably an aqueous solution of acetaldehyde) an intense violet colour is produced, while with green dye-stuffs, *e.g.*, malachite-green, a green coloration appears. Thiosulphates, di-, tri-, and tetra-thionates do not decolorise the above solution, and thus this reaction can be used to detect sulphites in presence of these salts. Bicarbonates,

sulphydrates, phosphates, &c., do not affect the reaction, but mono- and polysulphides behave like the sulphites; hence sulphur ions must be removed by means of zinc or cadmium ions. A mixture of fuchsine and malachite-green is the best to use, containing three volumes of fuchsine solution (0·25 grm. fuchsine to 1 litre of water) to one volume of malachite-green solution of the same strength. If the solution to be tested contains free alkali this must be converted into bicarbonate by means of a current of carbon dioxide. If the solution is acid pure bicarbonate must be added. The test is very sensitive; an aqueous solution containing only 0·00006 grm. of sulphurous acid in 1 cc. instantly decolorises the dye solution, and shows a violet coloration on addition of acetaldehyde. The following scheme shows how the test may be applied:—

I. The solution—
- (*a*) Decolorises the fuchsine malachite reagent, and becomes violet with acetaldehyde;
- (*b*) Gives a violet coloration with alkaline sodium nitroprusside solution;
- (*c*) After shaking with $CdCO_3$, filtering, and saturating with CO_2, the dye soluution is not decolorised, nor is S separated on acidifying.

It contains poly- or monosulphides, but no sulphite.

II. The solution—
- (*a*) Does not decolorise the dye reagent;
- (*b*) Gives no coloration with sodium nitroprusside solution.

It may contain thiosulphate, or di-, tri-, or tetrathionate.

III. The solution—
- (*a*) Decolorises the dye reagent;
- (*b*) Gives no coloration with alkaline sodium nitroprusside solution.

It contains sulphite and thiosulphate.

IV. The solution—
- (*a*) Decolorises the dye reagent;
- (*b*) Gives a violet coloration with alkaline sodium nitroprusside solution;
- (*c*) Treated as in I. (*c*), decolorises the dye-stuff, but gives no sulphur with acids.

It contains monosulphide and sulphite.

V. The solution—
- (*a*) Gives a violet coloration with alkaline sodium nitroprusside solution;
- (*b*) Decolorises the dye solution;
- (*c*) Treated as in I. (*c*), does not decolorise the dye solution.

It contains monosulphide and thiosulphate.

VI. The solution—
- (*a*) Decolorises the dye solution;
- (*b*) Gives a violet coloration with alkaline sodium nitroprusside solution;
- (*c*) Treated as in I. (*c*), decolorises the dye solution, and gives S with acids.

It contains monosulphide, sulphite, and thiosulphate.

The same method can be used for detecting sulphurous acid in presence of sulphuretted hydrogen in the gaseous state. The mixture of gases must be led through a U-tube with hot cadmium sulphate solution, and then through a U-tube containing the fuchsine malachite-green solution to which some sodium bicarbonate has been added. If this is decolorised and a violet coloration subsequently produced with acetaldehyde, sulphurous acid is present. Moreover, the same reagent may be used to distinguish dilute solutions of sulphydrate and sulphides, for the former do not decolorise the solution, while the latter do.

Solubility of the Alkaline Earths in their Fused Chlorides.—Kurt Arndt.—When calcium oxide is dissolved in fused calcium chloride and the melt allowed to solidify, it is found that lime begins to separate at 800°, and that at 800° at the most 7·0 per cent of calcium oxide is dissolved in the saturated melt. This is equivalent to 7·5 per cent CaO to 100 grms. $CaCl_2$. The solidification point of calcium chloride is not lowered by dissolving lime in it, which shows that calcium oxide forms a solid solution with the chloride. Similar experiments were performed with the oxides of strontium and barium, and the results may be stated as follows:—1 mol. of CaO dissolves in 7 mols. $CaCl_2$; 1 mol. of SrO dissolves in 3 mols. $SrCl_2$; 1 mol. of BaO dissolves in 2 mols. $BaCl_2$. The effect of the addition of fluor-spar on the solubility of lime in fused calcium chloride was then investigated. Fifty-four grms. of calcium chloride were fused with 6 grms. of calcium fluoride, and 7 grms. of calcium oxide were added; the solubility of the oxide was then found to be almost unaltered by the fluoride.

Hydrazoic Acid.—L. M. Dennis and Helen Isham.—The authors have prepared anhydrous hydrazoic acid by adding dilute sulphuric acid (two parts acid to one part water) to potassium trinitride in a current of dry carbon dioxide. The free acid was dried by passing it through calcium chloride tubes and collected in a vessel which was surrounded by a Dewar's vessel containing liquid air. The whole apparatus was placed behind a screen of thick plate-glass before which were wooden walls, and other precautions were taken to ensure the safety of the operator. The temperature was ascertained by means of a pyrometer. The acid yielded a white crystalline mass which slowly melted when the liquid air was allowed to evaporate. The melting-point was found to be −80° and the boiling-point about 37°. The acid is a colourless mobile liquid which is heavier than water and probably has a high surface tension. At ordinary temperatures it is apparently quite stable, but explodes readily and with great violence if it is shaken or strongly heated. The authors succeeded in analysing the anhydrous acid, and found its vapour density; the latter at a temperature only 25° above the boiling-point indicates that the compound has the monomolecular formula HN_3.

MISCELLANEOUS.

Royal Institution.—On Tuesday, April 9th, at 3 o'clock, Professor G. H. Bryan, F.R.S., will begin a course of two lectures on "Wings and Aeroplanes"; on Thursday, April 11th, at 3 o'clock, Professor H. A. Miers, F.R.S., will commence a course of two lectures on "The Birth and Affinities of Crystals"; and on Saturday, April 13th, at the same hour, Professor Silvanus P. Thompson, F.R.S., will begin a course of three lectures on "Studies in Magnetism" (The Tyndall Lectures). The Friday Evening Discourse on April 12th will be delivered by Professor A. H. Church, F.R.S., the subject being "Conservation of Historic Buildings and Frescoes," and on April 19th by Professor C. S. Sherrington on "Nerve as a Master of Muscle."

MEETINGS FOR THE WEEK.

MONDAY, 8th.—Society of Chemical Industry, 8. "Observations on Cotton and Nitrated Cotton," by H. de Mosenthal.

TUESDAY, 9th.—Royal Institution, 3. "Wings and Aeroplanes," by Prof. G. H. Bryan, F.R.S., &c.

WEDNESDAY, 10th.—Society of Arts, 8. "Arts and Industries in Hungary in Ancient and Modern Days," by Louis Felberman.

—— Society of Public Analysts, 8. "Bacterial Estimation of Phenol and Cresol," by M. Wynter Blyth and L. Goodban. "New Method for the Estimation of Tartaric Acid," by A. C. Chapman and P. Whitteridge. "Detection of Cocoanut Oil in Butter," by E. Hinks.

THURSDAY, 11th.—Royal Institution, 3. "The Birth and Affinities of Crystals," by Prof. H. A. Miers, F.R.S., &c.

FRIDAY, 12th.—Royal Institution, 9. "Conservation of Historic Buildings and Frescoes" (with Experimental Illustrations), by Prof. A. H. Church, F.R.S.

SATURDAY, 13th.—Royal Institution, 3. (The Tyndall Lectures). "Studies in Magnetism," by Prof. Silvanus P. Thompson, F.R.S.

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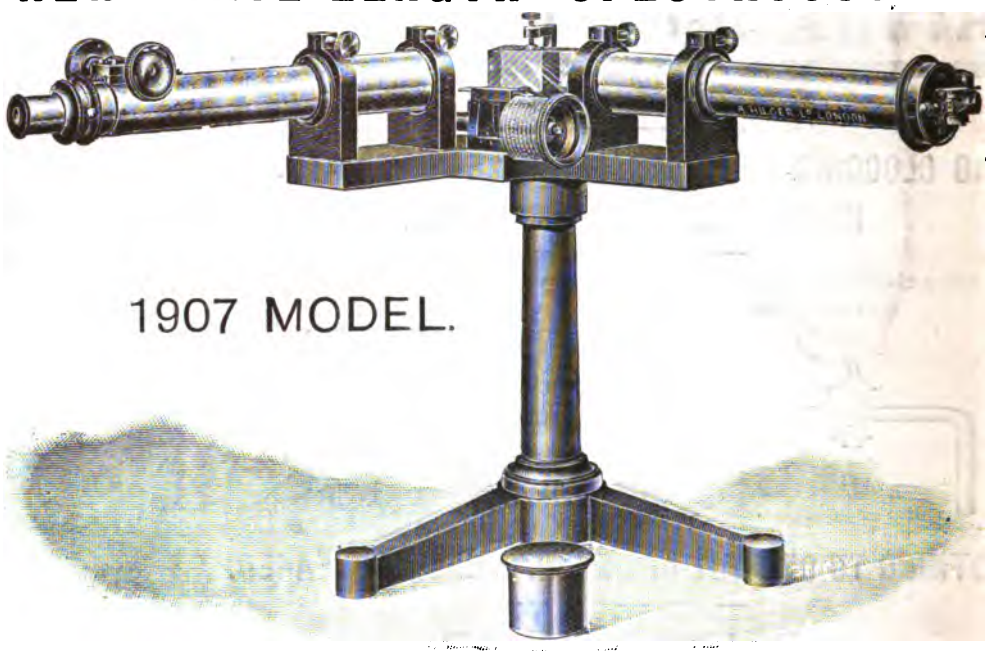

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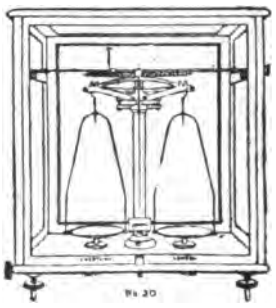

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By MAURICE R. READ.

1. When chromium trioxide is introduced on the end of a platinum-wire into a jet of burning hydrogen or the non-luminous flame of a Bunsen burner, the conversion of the trioxide into the green chromic oxide is accompanied by the production of a white light of dazzling brilliancy. The luminosity of the flash is little short of that emitted by burning magnesium, though the colour is an almost pure white instead of bluish white. The substance changes in tint from red to grey before the flash. That CrO_3 decomposes with some violence if heated to a temperature slightly above its melting-point is well known, but the writer has seen no reference to this distinctive behaviour of the oxide when introduced into a flame.

2. If the trioxide is gently heated in a stream of coal-gas or hydrogen a somewhat brilliant combustion ensues, three different residues remaining in the boat; a grey semi-fused powder in the central portions, a purplish substance at the ends, and beneath these a layer of the green sesquioxide of chromium. In the coal-gas experiment, the flame of a Bunsen burner, in which the issuing gas was burnt, at first exhibited luminosity, owing, no doubt, to escaping oxygen, but at the moment of the combustion in the tube the lividity disappeared. Similar effects were observed in the experiment in which hydrogen replaced the coal-gas.

3. Heated in a like manner in a stream of carbon dioxide, chromium trioxide yields, besides vapours imparting luminosity to a Bunsen flame, a small quantity of a brownish purple body resembling that already mentioned, but there is no combustion within the tube. The result of heating the trioxide in a stream of nitrogen is similar, but a dull bluish residue, dark green beneath, was obtained in place of the purplish substance formed in the previous experiments.

4. The vapour of chromyl chloride, passed into a non-luminous Bunsen flame, imparts to it a very characteristic livid whiteness, resembling that produced by the vapour of CrO_3.

5. The purple, brownish purple, and bluish residues above described, introduced on a platinum-wire into a non-luminous gas flame, emitted a brilliant light, closely similar to that caused by chromium trioxide.

The question has arisen whether the dark coloured residue obtained, which behaves in such a characteristic manner in a non-luminous flame, is possibly the "violet" oxide of chromium, Cr_5O_9, mentioned in Roscoe and Schorlemmer's "Chemistry," 'The Metals,' 3rd Ed., 1897, p. 836, or is it CrO_2 tinted by the presence of small quantities of undecomposed CrO_3?

On the former supposition (as suggested to me by Mr. E. G. Clayton, in whose laboratory I have made these experiments) such reactions as the following might have occurred:—

(*a*) $3CrO_3 = Cr_2O_3.CrO_3 + 3O$.
(Dioxide)

(*b*) $Cr_2O_3.CrO_3 + 2CrO_3 = 2Cr_2O_3.CrO_3 + 3O$.
(Violet or purple oxide)

(*c*) $4[2Cr_2O_3.CrO_3] = 10Cr_2O_3 + 3O_2$.
(Green oxide)

The experiments so far made have not settled the point

Chemical Laboratory, 23, Holborn Viaduct, E.C.
March 23rd, 1907.

THE IGNITING POINT OF SULPHUR.*

By J. RUTHERFORD HILL, Ph.C.

At a meeting of the Pharmaceutical Society in 1890, I described an experiment indicating 248° C. as the igniting point of sulphur in air at ordinary atmospheric pressure (*Pharm. Journ.* xx., [3], p. 722). The apparatus employed is figured in Chemical News, lxi., p. 126.

Dr. W. R. Hodgkinson, of Woolwich, criticised this figure, and remarked that anything below 300 C. "is quite out of the question" (Chemical News, lxi., p. 96). His reason for this opinion is that a thin stream of boiling sulphur (temperature 448° C.) can be poured through air into water without ignition taking place, and this is assumed to be inconsistent with the statement that the igniting point in air is 248° C. Dr. Hodgkinson overlooks the fact, indicated in my paper, that he is pouring the liquid sulphur through an envelope or tube of vapour, much colder on the outside than the boiling sulphur, and which effectually prevents the free access of air shown to be necessary for ignition.

Mr. Bertram Blount repeated my experiment with a slightly modified apparatus, and found the igniting point 261° C., which he accepted in place of his previous determination of 270° C., on the ground that my method eliminated the previous sources of error (Chemical News, lxi., p. 153).

In December, 1903, there appeared in the *Pharmaceutical Journal* a brief abstract announcing that H. Moissan had determined the igniting point of sulphur in oxygen at ordinary atmospheric pressure to be 282° C., and in air 363° C.

This differed so widely from all previous determinations, that I wrote a letter to the Editor of the *Pharmaceutical Journal* affirming that the actual temperature of ignition was not lower than 248° C., and not higher than 261° C., and asking particulars of Moissan's method (*Pharm. Journ.*, [4], xvii., p. 939). There being no response to this letter, I communicated direct with H. Moissan in May, 1904, but received no reply. The recent decease of H. Moissan recalled the circumstance to my mind, and induced me to re-examine the subject. On looking up Moissan's original paper (*Comptes Rendus*, cxxxvii., p. 547) it is found that after several experiments he adopts the following method:—

"Some fused sulphur is kept in an atmosphere of CO_2 to prevent all formation of SO_2, and the oxygen is heated in the bath of liquid sulphur, in the middle of which the experiment is conducted. For this purpose we have placed 150 grms. of fused sulphur at the bottom of a flask of 250 cc. By means of a glass tube bent at a right angle, we conducted to the surface of the fused sulphur a sufficiently rapid current of dry CO_2. The oxygen was led in by a straight glass tube, whose end was completely submerged for a length of 5 to 6 cm. in the liquid sulphur, and was terminated by a narrow point.

"The oxygen was disengaged bubble by bubble much more slowly than in the previous experiments (which were at the rate of one litre in ten minutes). A thermometer indicated the temperature of the sulphur. Lastly, the flask was placed on a sand bath which was cautiously heated. Under these conditions, while the temperature is below 282° C., the oxygen disengaged bubble by bubble through the liquid sulphur produces SO_2, but without incandescence. On the other hand, when this temperature is reached, a more active reaction begins by a slight explosion, which is immediately followed by the phenomenon of incandescence. Beyond this temperature, the combination of oxygen and sulphur takes place with flame and with disengagement of heat, which rapidly increases and raises the temperature of the fused sulphur. The temperature of ignition of sulphur in oxygen under a

* Read before the Pharmaceutical Society of Great Britain, March 20, 1907.

pressure of one atmosphere is therefore 282° C. Under the same conditions, using air instead of oxygen, the temperature of ignition is 363° C. This combustion in the middle of a bath of fused sulphur has a blue flame, but being produced in a yellow liquid, it appears green. When the temperature is lowered to 360° C., the flame is no longer formed, and from this point, if the current of CO_2 is not very rapid at the surface of the sulphur, a series of explosions is produced, due to the mixture of air and sulphur vapour; that is to say, the temperature of ignition of this vapour of sulphur is lower than that of liquid sulphur, and is produced in air near 285° C.

"This temperature of ignition is rapidly raised when the air contains SO_2. In a mixture of 95 per cent of dry air and 5 per cent of SO_2 the igniting point is near 445° C. In 90 per cent of dry air and 10 per cent of SO_2, ignition does not take place at 465° C."

As Mr. Blount very properly remarks, the difference between his figure and mine may be due merely to difference in the actual dimensions and arrangement of apparatus and area of the surface of glass in contact with the mixed gases. The temperature of the ingoing current of air, and probably also the relative proportions of air and sulphur vapour, may make a difference of a few degrees, but a difference of 115° C. demands some other explanation.

I have repeated my experiment with apparatus of slightly larger dimensions, but otherwise identical with that figured in the CHEMICAL NEWS, except that, in addition to the thermometer in the sulphuric acid bath, there was a second thermometer inside the tube containing the sulphur. When both thermometers indicated 255° C., the sulphur vapour and air ignited, and continued to burn with a blue flame on the top of the sulphur in the bottom of the tube. Owing to a slight displacement of the aspirator, the thermometers had fallen to 246° C. before the air supply could be renewed, and at this temperature the vapour of sulphur refused to re-ignite. There was no time to repeat the experiment, but this is ample confirmation of the results obtained by me in 1890.

I have had some difficulty in following Moissan's process. He says that the igniting point in air at a pressure of one atmosphere is 363° C. But he conducts the air into the liquid sulphur through a tube which is immersed in the sulphur to a depth of 5 or 6 cm., or about 2½ inches. Liquid sulphur has a specific gravity of nearly 2, and therefore the pressure under which the air enters the sulphur, instead of being 760 mm. must be nearer 770 mm. I do not understand why he uses an atmosphere of CO_2 to wash out any SO_2. It would be as effectual and more suitable to use ordinary air, in sufficient quantity as I have done. Had he done so, it seems probable he would have got a very different result. He makes the statement that a mixture of sulphur vapour and air ignites about 285° C. From this, one might infer that he means to distinguish between the igniting point of sulphur in vapour and liquid sulphur. But is any such distinction possible? The igniting point of any volatile substance is surely the point at which its vapour inflames in air. Taking his own case, whenever a bubble of air enters the liquid sulphur it will be instantly saturated with sulphur vapour, and it is this mixture that becomes incandescent. More than that Moissan has shown that sulphur and oxygen combine to form SO_2 below the ignition point, consequently the confined portion of air in the bubble will at once become more or less contaminated with SO_2. He points out that a contamination with 5 per cent of SO_2 raises the igniting point to 445° C. May it not therefore be that his method, owing to the sources of error indicated and the abnormal conditions of the experiment, is altogether unreliable as an indication of the temperature at which sulphur ignites when freely exposed to the air at ordinary atmospheric pressure? My experience is that though some SO_2 may be formed, the quantity is very small, under the conditions of my experiment. I do not think it is the SO_2 which prevents ignition, but the formation of an envelope of vapour of sulphur, comparatively cold, which prevents the air getting access to the surface of the sulphur where the hot vapour is being given off. Moissan does not seem to take any account of this atmosphere of sulphur as an interfering agent, and I believe it to be the more important.

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 158).

Confirmatory Experiments and References (continued).

Action of H_2SO_4 *on* Al_2O_3 *and* TiO_2. — Two grms. coarsely powdered corundum, which had been previously digested with HF, and 0·5 grm. rutile were in separate experiments boiled with 10 cc. H_2SO_4 (1·84) in a covered casserole for fifteen minutes; the mixture was diluted, filtered, and the filtrate made alkaline with NH_4OH; about 50 mgrms. Al and about half the titanium were precipitated as hydroxides.

100 mgrms. Al as Al_2O_3, obtained by igniting $Al(OH)_3$, were boiled with 5 cc. H_2SO_4 (1·84) in a covered casserole for ten minutes; a residue containing 10 to 20 mgrms. Al was left undissolved, and this did not dissolve completely on two more treatments with H_2SO_4. The experiment was repeated with 200 mgrms. Ti as ignited TiO_2; nearly all of it dissolved in three to four minutes.

P. 6, N. 1: *Action of Boiling Sodium Carbonate Solution on* $BaSO_4$, $Cr_2(SO_4)_3$, *and* Sb_2O_5.—500 mgrms. Ba as $BaSO_4$ were treated by the procedure; a residue of $BaSO_4$ corresponding to about 30 mgrms. Ba remained on adding HCl. This residue was treated a second time by the procedure; not more than 1 to 2 mgrms. Ba as $BaSO_4$ then remained.

100 and 200 mgrms. Cr as anhydrous $Cr_2(SO_4)_3$, obtained as described under C. E., P. 5, N. 4 and 5, were boiled with Na_2CO_3 in a covered casserole as described in P. 6; the pink precipitate slowly became greenish blue in colour. The Na_2CO_3 solution was acidified with HCl, and $BaCl_2$ added to it; a precipitate of $BaSO_4$ was formed, thus showing that chromic sulphate was being decomposed.

The greenish blue residue from the experiment with 100 mgrms. Cr (which in contrast to the anhydrous sulphate filtered easily) was boiled with HCl; some chromium dissolved, but the greater part was left as undecomposed anhydrous sulphate.

The greenish blue residue from the experiment with 200 mgrms. Cr was boiled for about two hours with seven successive portions of Na_2CO_3 solution, and these solutions were tested for sulphate. The sulphate in these portions steadily decreased in amount and the last portion was free from it. The greenish blue residue now dissolved completely in HCl on warming, and the solution gave no precipitate with $BaCl_2$, showing that the chromic sulphate had been completely converted into the hydroxide.

100 mgrms. Sb as antimonic hydroxide, obtained as described under C. E., P. 5, N. 4 and 5, were boiled with 25 cc. Na_2CO_3 solution in a covered casserole for fifteen minutes; the solution was acidified, and treated with H_2S; an orange precipitate of sulphide was obtained which was estimated to contain 3 to 4 mgrms. Sb.

*P. 6*a*, N. 1: *Precipitation of* H_2WO_4 *from* Na_2CO_3 *Solution by Acids.*—One mgrm. W as Na_2WO_4 was added in separate experiments to 5 cc. H_2O, to 5 cc. saturated Na_2CO_3 solution, and to 20 cc. Na_2CO_3 solution; HNO_3 was added in excess, and the solutions evaporated almost to dryness; yellow H_2WO_4 separated in the presence of HNO_3 alone, but not in the solutions containing $NaNO_3$. The latter were diluted with enough hot water

* From the *Technology Quarterly*, xix., No. 3 September, 1906.

to dissolve the salt, 1 to 2 cc. HNO_3 (1·20) were added, the solutions were boiled vigorously, and then cooled; yellow H_2WO_4 precipitated in the solution containing the smaller amount of salt, but not in the other solution:—The experiment with 20 cc. Na_2CO_3 solution was repeated except that 2 mgrms. and 3 mgrms. W (in separate experiments) were taken; no yellow precipitate was obtained with 2 mgrms., and only a slight one with 3 mgrms., thus showing that the presence of $NaNO_3$ interferes with the test.

Solutions containing, respectively, 1, 2, 5, 10, and 20 mgrms. W as Na_2WO_4 in 20 cc. Na_2CO_3 solution were evaporated with excess of H_2SO_4 to strong fuming, diluted to about 15 cc., boiled, and cooled again; no yellow precipitate was formed in any of the experiments:—Solutions containing 2, 3, 5, and 10 m.grms. W as Na_2WO_4 in 20 cc. Na_2CO_3 solution were evaporated with excess of HCl almost to dryness, diluted to about 15 cc., boiled, and cooled; no yellow precipitate was formed. The final solutions obtained in all these experiments turned blue when some granules of zinc were added, though the colour from 1 mgrm. W in H_2SO_4 appeared only after several minutes.

*P. 6*a*, N. 2: *Reduction of* H_2WO_4 *with Zinc*.—See v. d. Pfordten, *Ber.*, 1883, xvi., 508.

To 10 mgrms. W as Na_2WO_4 in a test-tube were added 5 cc. water, 5 cc. HCl (1·12), and a few granules of zinc; a white precipitate separated when HCl was added, and a deep blue colour resulted from the action of the zinc; after half-an-hour the blue colour had changed to a dark brown, and a dark coloured precipitate was suspended in the solution.

*P. 6*a*, N. 3: *Solubility of* H_2WO_4 *in Acids*.—Two mgrms. W as Na_2WO_4 were treated by P. 3, 4, and 5 except that no HF was added; a yellow precipitate of H_2WO_4 was obtained on boiling with HNO_3, and was not dissolved by dilute HNO_3 after the evaporation (P. 3); the residue dissolved in HCl (1·20) on boiling, but H_2WO_4 was re-precipitated on evaporating the aqua regia, and was not dissolved by the dilute HCl (P. 4). Nearly all the residue dissolved, however, in 2 cc. H_2SO_4 (1·84), and did not re-precipitate on diluting to 20 cc., and boiling (P. 5). (For the solubility of H_2WO_4 in concentrated H_2SO_4, and after dilution, see *Technology Quarterly*, 1904, xvii., 249).

P. 7. N. 2: *Effect of Fusing* Al_2O_3, SnO_2, TiO_2, MoS_2 *with* Na_2CO_3 *or with* Na_2CO_3 *and* KNO_3.—For the fact that a large residue remains when native Al_2O_3, TiO_2, and SnO_2 are fused with Na_2CO_3, see *Technology Quarterly*, 1903, xvi., 127.

80 mgrms. Al as Al_2O_3, obtained by igniting precipitated AlO_3H_3 over a blast-lamp for fifteen minutes, were fused with 8 grms. Na_2CO_3 in a platinum crucible over a powerful burner for twenty minutes; 0·2 grm. KNO_3 was then added, and the heating continued for ten minutes longer; the fusion was cooled, and digested with HCl; only a small residue of unattacked Al_2O_3, corresponding to 5 to 10 mgrms. Al, remained. The solution gave no precipitate with H_2S, showing that platinum had not been removed from the crucible.

500 mgrms. Mo as molybdenite (MoS_2) were fused for three to five minutes in a porcelain crucible with 10 grms. Na_2CO_3, and the mass treated with water; the black particles of MoS_2 all dissolved during the fusion, and the mass, which had a light red colour, dissolved nearly completely in water. HCl was added to the solution; a large black precipitate separated.

150 mgrms. Mo as molybdenite were fused for about two minutes in a platinum crucible with 8 grms. Na_2CO_3 and 0·5 grm. KNO_3, and the mass was treated with dilute HCl; complete solution resulted; the platinum crucible was not injured:—The experiment was repeated, except that the KNO_3 was added after a minute's fusion with Na_2CO_3; the result was the same.

P. 7, N. 2 and P. 8, N. 3: *Effect of Fusing* Al_2O_3, SnO_2, TiO_2 *with* KOH.—200 mgrms. of coarsely powdered corundum (Al_2O_3) that had been previously digested with HF and with concentrated H_2SO_4 and 200 mgrms. of finely powdered cassiterite (SnO_2) were fused with 10 grms. KOH in nickel crucibles for fifteen minutes; the mass was extracted with water, and the residue heated with HCl; a residue still remained, which was estimated to contain about half the Al_2O_3, but little, if any, of the SnO_2. An analysis was made of the aqueous extract and of the HCl solution; the former was found to contain about 50 mgrms. Al (as aluminate), and 100—150 mgrms. Sn (as stannate), but no nickel; the HCl solution contained 20 to 40 mgrms. Sn, 10 to 15 mgrms. Ni, and some Fe as chlorides, but no other metallic element.

One grm. of rutile containing 600 mgrms. Ti was treated by P. 3, 4, and 5; the residue was fused with KOH for about five minutes as described in P. 7, N. 3; the mass was extracted with water, and the residue treated with cold HCl (1·12); the rutile was not attacked by HNO_3 (P. 3) nor by HNO_3 and HCl (P. 4), but about 300 mgrms. Ti were dissolved by H_2SO_4 and HF (P. 5); much of the TiO_2 dissolved in the fused KOH, but only 2 to 3 mgrms. Ti passed into solution on treating the mass with water; out of the residue, which consisted of a black and white mixture, about 200 mgrms. Ti dissolved on treating with HCl (1·12); and a black residue of unattacked rutile still remained, which weighed 150 mgrms., corresponding to about 90 mgrms. Ti. This was powdered finely, again fused with KOH for fifteen minutes, and extracted with dilute HCl; all but 3 to 4 mgrms. Ti dissolved.

P. 8, N. 3: *Foreign Substances introduced from Porcelain or Nickel Crucibles*.—Ten grms. of a mixture of K_2CO_3 and Na_2CO_3 were fused in a porcelain crucible for half-an-hour over a powerful burner, the mass treated as described in the procedure, and the residue and solution analysed separately; the residue after the evaporation to dryness with HCl was shown by P. 5 to contain several mgrms. of SiO_2; the solution was found to contain several mgrms. of aluminium and of calcium, and a trace of iron. Compare also C. E., P. 8, N. 5 below.

The experiment was repeated, using a nickel crucible; the aqueous extract acidified with HCl gave no precipitate with H_2S, nor with NH_4OH and $(NH_4)_2S$. A slight black residue of nickel oxide insoluble in water remained; this dissolved in HCl, and gave a precipitate with NH_4OH and $(NH_4)_2S$, which was estimated to contain 1 mgrm. Ni. This experiment was repeated, except that 0·3 mgrm. KNO_3 was added to the fusion; 4 to 5 mgrms. Ni as nickel oxide were obtained.

Reduction of Silver and Lead Compounds by Fusion in a Nickel Crucible.—200 mgrms. Ag as precipitated AgCl were fused with 10 grms. of a mixture of Na_2CO_3 and K_2CO_3 in a nickel crucible for ten minutes, and the mass extracted with water; a residue of bright coloured metallic silver soluble in HNO_3 was left as a loose mass which did not adhere to the crucible, there being no evidence of the formation of an alloy.

200 mgrms. Pb as precipitated $PbSO_4$ were fused as in the preceding experiment; neither the aqueous extract (when acidified with HCl) nor the HCl solution of the residue gave precipitates with H_2S. The lead salt was completely reduced to metallic globules which had melted on to the nickel crucible, and were not dissolved off by fusion with KOH, KOH and KNO_3, KOH and Na_2O_2, or Na_2O_2 alone.

P. 8, N. 5: *Behaviour of Antimony and Tin Compounds on Fusion with Sodium Carbonate*.—60 mgrms. Sn as $SnCl_2$ and 50 mgrms. Sb as $SbCl_3$ were fused in a porcelain crucible with 10 grms. of a mixture of K_2CO_3 and Na_2CO_3 for half-an-hour; the fusion was extracted with water and with HCl as described in the procedure, and the solutions separately analysed; the aqueous extract contained nearly all the antimony and tin, a few mgrms. of silica, aluminium, and a little calcium; the HCl solution contained 4 to 5 mgrms. antimony, and 1 to 2 mgrms. each of aluminium, iron, and calcium.

(To be continued).

PROBLEMS OF APPLIED CHEMISTRY.*

By Prof. GEORGE LUNGE.

(Concluded from p. 162).

WE, who have been born to see the ascendency of coal as the principal producer of energy in bulk, can hardly realise what a short epoch in the past and future history of mankind belongs to the age of coal. It has taken many thousands of years to form the beds of coal which exist in the earth's crust, and which have preserved to us a tiny portion of the solar energy radiated upon our planet during that period, millions of years ago. At that period, for various reasons, the production of living matter must have been incomparably more rapid than is the case at present. During untold ages this stored-up energy was lying idle, hidden under the accumulations of the more recent geological formations, not merely up to the advent of man, but through nearly the whole of his history. Leaving aside the tens of thousands or (according to some) hundreds of thousands of years during which man existed before the dawn of history, we must remember that historical documents exist in Egypt, Babylon, India, and elsewhere, taking us back at least 8000 years, and that the most glorious times of Greek and Roman civilisation are about 2000 years behind us. How modern, in view of these figures, is the use of the coal, and over what a short time it will extend! In these isles the use of coal is much older than in any other country, but even here its serious exploitation is comparatively recent, dating barely 150 years back; whilst its future (even if we disregard the more pessimistic estimates) is not likely to exceed some 200, or at most 300, years. Germany and the United States will probably hold out 200 or 300 years longer, but in all other countries the chances are all the other way.

Well, what is to happen then? Those countries where water power is abundant may possibly substitute electrical heating for that produced by the burning of coal, but what about England and Germany, which are so poorly off in that respect? Even in those countries which are more favoured the amount of water power is by no means infinite; and, if it had to be drawn upon, not merely for motive purposes, but for the production of electricity for heating purposes, it would be found insufficient in most places. Here we are faced by one of the greatest problems of applied science, both in chemistry and in physics, a problem which will give plenty of occupation to generations of future inventors. At present we can only surmise that some solution will present itself in the shape of a direct conversion of the sun's rays into other forms of energy; but the means by which this would be practically accomplished are at present quite uncertain.

The Age of Coal, in the midst of which we are living, short as it is evidently doomed to be in the long history of mankind, has been of incalculable service. For our purposes we may dismiss the earlier part of it, and look back only a hundred years. In all branches of industry, in locomotion, in the means of communication, and in innumerable matters ministering to the comforts of life, the progress since that time has been going on at a geometrical ratio. The present state of all these factors of civilisation in Europe (to say nothing of America) differs from that obtaining a hundred years ago far more than the latter differed from the Roman Era, or even from the age of the Egyptian kings. And this miracle has been brought about solely by *coal*, without the aid of which it is simply impossible to imagine the revolution which has taken place since then. "Railways!" That single word, to give only one instance, will bring this home to anyone who ponders over this matter. And it is equally impossible for us to imagine that, during the past century, there could have been any other invention, based upon the utilisation of the other supplies of energy of which we have spoken, which could have replaced the untold services of coal, that accumulator of solar energy, which alone has enabled the human mind to work out the thousand and one channels through which modern civilised life is flowing. We may say this with all confidence, for how otherwise could we account for the fact that such inventions have not been made in former times, when there were certainly quite as many ingenious minds in the world as during the coal-consuming age?

Let us now come down to considerations of a more modest, but more practical nature than those in which we have just been indulging. Seeing that the stock of mineral fuel upon this earth is so very limited, cannot we find means of husbanding it more than this has been done hitherto? It is only too notorious that the way in which coal is at present consumed is most wasteful. Of the energy residing in coal, most ordinary steam-engines utilise less than 10 per cent by converting it into mechanical motion; and even the most perfect steam-engines devised utilise hardly more than 15 per cent. Improvements in this direction may possibly swell this proportion a little, but there is no prospect of gaining much in that direction. Enormous wastages are also incurred in other ways. The conversion of pig-iron into steel, the manufacture of glass, and many other industries consumes from four to twenty times, and even more, of the quantity of coal required by theory. Many descriptions of coal are too poor to be used at all, except in the immediate vicinity of the spot where they occur; and in burning our fuel, whether it be for industrial or for technical purposes, we invariably send its nitrogen into the atmosphere, which surely contains quite enough of that commodity; the only exception being the manufacture of coal-gas, to which we shall refer later on. Here some of the grandest problems of applied chemistry present themselves to us—how to stop that fearful waste of fuel; and how to recover the nitrogen of the coal, if that be possible.

It is certain that we must look for the solution of these questions in the direction of converting coal into gaseous fuel. It is true that much has been done in that field in past years, and more especially will the name "Siemens" occur to every one in this connection, but much more remains to be accomplished. Another great stride ahead lies in the better utilisation of the waste gases from blast furnaces, in which respect the last few years have witnessed some very important improvements. All this refers merely to a better utilisation of the heating power of coal, but not to that other great task, the recovery of its nitrogen in a useful shape. This, together with the question how coal of poor quality is to be turned to a better account, has been tackled by the equally indefatigable and intelligently directed energy of Dr. Ludwig Mond, one of the benefactors of the Royal Institution. His invention, the "power-gas," has already attained a large measure of success, as is proved by the extent of the plants erected and designed. Mond's process belongs to that class by which we approach one of the greatest problems, for the time being, of applied chemistry; I mean the conversion of nitrogen from sources not yet opened out into ammonia and nitrates.

The immense importance of this latter problem lies in the fact that it touches our most urgent want, our supply of food. The soil of most countries, if tilled in the old manner, would not nearly suffice for the production of the requisite amount of food for men and cattle, while the limits of its producing capacity are being gradually narrowed down by exhaustion. Sir William Crookes, in his address to the British Association in 1898, has most forcibly drawn attention to this. The importation of food-stuffs from other less thickly populated countries can only modify, but not altogether extinguish, the danger of ultimate shortness of food at some future date, possibly not so very remote. It is certainly a great comfort to know that, with suitable manuring, the soil may be forced to yield even better crops than it would give in the virgin state, let alone in a condition impoverished by centuries

* A Discourse delivered at the Royal Institution, March 15, 1907.

of tilling. But stable manure is nothing like sufficient to attain that object, and we must turn to mineral fertilisers, principally phosphates, potassium salts, and nitrogen compounds. The two former classes of fertilisers are found in abundance in nature, and there is no danger apparently of their being exhausted during the next thousand years.

But the case is very different with the mineral forms of nitrogenous manures, *i.e.*, ammonium salts and nitrates. For agricultural purposes it does not make much difference whether we apply the nitrogen in one or the other of these forms. The ammonia, apart from insignificant quantities otherwise obtained, all comes from the nitrogen of the coal, but up to about twenty years ago only that coal which was used in the manufacture of gas was made to yield ammonia, and only one-sixth of its nitrogen was obtained in this form. In all other uses of coal, where at least twenty times as much is consumed as in the manufacture of gas, the nitrogen was simply sent into the air.

Quite recently, some progress has been made in the way of utilising some of this nitrogen as well. I have already mentioned the Mond process, where some of the nitrogen is recovered in the shape of ammonia; but this covers only one corner of the field. In another section a good deal has been already achieved. In the manufacture of coke, which is also a process of destructive distillation, and entirely analogous to gas making, very much larger quantities of coal are consumed than for the latter, since coke is indispensable for the smelting of iron and for other metallurgical purposes. Up to about twenty years ago all the volatile by-products in the manufacture of coke were lost—that is to say, tar, gas, and ammonia. The recovery of these by-products was first carried through in one or two French coke-works, about 1861, but nowhere else for a number of years, although in 1879 the late Dr. R. Angus Smith had earnestly recommended to the English coke-works the adoption of that system. Even now, both in France and England as well as in America, the recovery coke-ovens have found only a very limited adoption; in England perhaps 5 per cent of the coke is made in this way, against upwards of 50 per cent in Germany. In consequence of this, whilst twenty years ago Germany imported nearly all ammonium sulphate required for its agriculture from this country, she now imports none, and has, on the contrary, become a large exporter of that commodity. The reasons for this wonderful change are various. One of them is undoubtedly the revival of that spirit of push and enterprise which, after lying dormant for centuries in consequence of the ravages of the Thirty Years' War, caught up the German people, and enlivened German industry in all directions. Without going into details on this matter, we may take it that a considerable reserve of ammoniacal nitrogen exists in the quarter indicated, and that the present production of about half a million tons of ammonium sulphate might be greatly increased in that manner.

But that reserve, is, after all, nothing like sufficient to cover the requirements of agriculture in the future; and it is quite likely that in the long run all the really available nitrogen of the coal would not suffice for the wants of man. And what about the time when coal itself will be exhausted? Well, there is an eternal and inexhaustible source of nitrogen to which we must turn, and that is the atmospheric air. Four-fifths of this consists of nitrogen, calculated to amount to 4000 billions of tons, mixed with a quarter of that weight of oxygen. More than 100 years ago, in 1785, Cavendish discovered the fundamental fact that, by the action of the electric arc, the nitrogen of the air combines with oxygen to form nitric acid. The formation of ammonia from atmospheric nitrogen has also been effected, both by electricity and (which is more important) in other ways as well, as we shall see anon. But until a very few years ago these facts have never been put to any practical use, and the problem of turning the atmospheric nitrogen into ammonia, or nitric aid, although frequently approached in a purely scientific or, experimentally, in a technical way, had not been solved. Our days have seen the realisation of that most important task.

Let us first speak of ammonia. We are led up to this by what is, verily, a long and circuitous path. We must start from the discovery of calcium carbide (announced in 1862 by the celebrated Woehler), the technical preparation of which substance was first effected by Wilson in 1892, and about the same time by Moissan. True, the expectations that were entertained in various quarters in connection with this remarkable chemical product have not been fully realised to the extent anticipated by the inventors; but, on the other hand, an entirely novel use has been discovered for it by Professor Adolf Frank and Dr. Caro, of Berlin. They found that when nitrogen is passed over red-hot calcium carbide it is absorbed with formation of calcium cyanamide. This latter, when treated with water under high pressure, is made to yield ammonia; but it is not necessary to do this, since the crude product, which they have called "lime-nitrogen," can serve directly as nitrogenous fertiliser, and is in that respect equivalent to its own weight of ammonium sulphate. This is, indeed, its principal use for the present and the near future; but, as a matter of fact, the discoverers go much further. From the lime-nitrogen they prepare cyanogen derivatives of various kinds, some of which are valuable as constituents of explosives, and they are earnestly trying to employ it in the manufacture of nitric acid. They have also brought in several other industries—the manufacture of pure graphite, of pure hydrogen, of urea, and so forth. The pure nitrogen required for all this was at first produced by passing atmospheric air over red-hot copper; but it is now made by liquefying air and distilling off the oxygen, which is thus obtained as a valuable by-product. The inventors expressly recognise the invaluable aid which they have in this respect derived from the world-renowned researches of Sir James Dewar, carried out in the Royal Institution. The works already in operation, or in course of construction, will by the end of this year utilise water-power to the extent of some 55,000 horse-power, and will produce lime-nitrogen equivalent to 100,000 tons of nitrate of soda, and this with an expenditure of force less than one-third of that required for the process of Birkeland and Eyde, of which I shall speak directly.

I must, however, first say a word about the strenuous efforts made by Professor Frank and Dr. Caro, this time in connection with Dr. Ludwig Mond, to extract from *peat* both power and ammonia. Enormous, but hitherto almost worthless, deposits of peat exist in Ireland and North Germany; and the ultimate success of these endeavours, which we have every reason to hope for, will prove an incalculable boon to these countries. At the same time, all fears of a scarcity of ammonia for agricultural purposes would be thus removed for generations to come.

Important as ammonia is as a fertiliser, it ranks after the nitrates in that respect; and, unlike ammonia, the nitrogen of the nitrates is of immense importance for other purposes as well, viz., the manufacture of nitric acid and of explosives. The very limited quantities of nitrates required in former times, amounting to a few tens of thousands of tons per annum, were furnished by Indian saltpetre, that is, crude potassium nitrate. A far more abundant supply was opened out a little more than half a century ago, when the exploitation of the beds of nitrate of soda in South America was begun. The crude nitrate found there is refined on the spot, and comes to us as "Chilian saltpetre," which is almost pure sodium nitrate, to the tune of a million and a half tons per annum. About four-fifths of this is taken up by agriculture, the remainder serving, in the first place, for the preparation of nitric acid. As for that acid, it is impossible to imagine how we could do without it. Apart from minor, but quite indispensable uses, one of which is in the manufacture of sulphuric acid by the lead-chamber process, the greater part of nitric acid is consumed in the manufacture of coal-tar colours and in that of explosives.

Let us pause for a minute to consider the last-named. Even supposing it possible that all wars could be abolished on this terrestrial globe—a contingency not very likely to arise within the next few years, in spite of the laudable efforts of the Peace Societies—and that gunpowder were no longer required for shooting wild animals (an equally unlikely case, which would lead to a quite intolerable increase of game, big and otherwise)—we cannot conceive the possibility of our present system of civilisation enduring without a colossal consumption of explosives. How could we carry on mining operations without them? How could we get stones from the quarries? How could we construct roads, and tunnels, and railways without the help of explosives, all of which have a basis of salts or esters of nitric acid? And these have, up to the present, been prepared almost exclusively from Chilian saltpetre. The idea has certainly been mooted to imitate the natural process by which the nitrate is formed in India. This has been tried during a number of years in France and in Sweden, but has been given up as unprofitable in our northern climes. Also, the interesting experiment of sowing the bacillus of nitrification and of cultivating it in the soil has proved a failure, although I would fain believe that the last word has not been spoken on that subject. This, if successful, would replace some of the nitrate now used as fertiliser, just as a better utilisation of sewage would act in the same direction; but all this at the best goes only a very small way, and does not furnish the pure saltpetre required for the manufacture of nitric acid. What, then, shall we do when the nitre beds of Chili are exhausted? an event which, according to most estimates, is bound to take place within thirty ar forty years from now. Unfortunately, there is no tangible hope of similar beds being found in any other localities, certainly not to any great extent. The beds of Atacama and Tarapaca on the Cordillera owe their origin to an altogether exceptional combination of climatic conditions and geological changes, the repetition of which in other quarters is exceedingly unlikely. Until very few years ago there was no prospect of any fresh supplies of nitrates in any other direction; but we may say that the solution of *this* problem, if not altogether settled in its final shape, has now been found. After many unsuccessful attempts at realising for practical purposes the discovery of Cavendish, and after a thorough investigation of its scientific principles by Lord Rayleigh, Muthmann and Hofer, Nernst, Haber, and others, this has been achieved, and once more, by means of that well-nigh omnipotent agent, electricity, which thus renders yet another service to mankind. At Notodden, in the Norwegian Hitterdal, a factory has been established to carry out the process of Birkeland and Eyde, who, by an ingenious application of the extreme heat produced by the electric current, make the nitrogen and oxygen of air combine to nitric oxide, which at a lower temperature is spontaneously oxidised into nitrous vapours, with the ultimate production of nitrites or nitrates. This time there is really no doubt that a practicable and economical process has been discovered for which it is intended to employ, by the end of this year, water power to the extent of 30,000 H.P. The Notodden process bids fair to be followed by other even more efficient processes. The most imporrant of these is that of the Badische Anilin- and Soda-Fabrik, for which an experimental factory is in course of construction, and for which 50,000 H.P. are to be employed. But for some time to come the Chilian saltpetre will still rule the trade; a very large amount of water power will, indeed, have to be brought into use merely to cover the annual increment of consumption of this commodity for agricultural purposes.

One task it is certain that explosives will never fulfil, and that was suggested to me by one of the cleverest mechanical engineers I have known. He was intensely interested in the problem of aerial navigation, and for this purpose he wished to construct an engine worked by fuel of the most concentrated kind. Neither coal, nor benzine, nor oil would do. In his plight he came to me and asked what explosives I should advise him to try for working his engine, in the erroneous idea that explosives were a kind of concentrated fuel. Of course, I could not but reply as follows: All honour to his courage, but no explosive known, so far ever or likely to be invented, could possess that property he required, viz., a large store of energy. A pound of coal represents five time as much energy as a pound of the strongest explosive known—blasting gelatine. My friend had overlooked the fact that a pound of dynamite, though it gives out nearly 150 million horse-power, does so only for the space of 1/50,000 of a second. He had omitted to take into account the element of *time* and had confused *power* in the ordinary sense with *energy*, which is the capacity for doing work.

A similar confusion is sometimes made between energy and the creation of high temperatures. This can be very well illustrated by the use recently made of finely-powdered aluminium, both as a component of explosives and as an agent for producing very high temperatures, in the shape of Dr. Goldschmidt's "thermite." In both cases the fact is utilised that aluminium is easily, and in the shape of fine powder, almost instantaneously, converted into its oxide, alumina, by substances capable of giving off oxygen. In the case of thermite, a mixture of finely-powdered aluminium and ferric oxide is, when lighted, decomposed instantaneously into molten iron and aluminium oxide. The heat produced thereby far exceeds that produced by coal in any conceivable way; it is equal to that of the electric arc. One of the most important applications of this agent occurs in the welding of the ends of railway rails, when already laid down, into one continuous rail of any length required. And yet the total energy of thermite is only 450 thermal units per kilogram, or in other words, about one-twentieth of that of the best coal. But, whereas it takes a good deal of time to burn a pound of coal, during which process there is a great loss of heat by radiation, and the heat is spread over a current of gases which we call the flame, a pound of thermite burns off in about one second, and, as there are no gaseous products formed, all the heat generated remains within the molten iron and the alumina, which accounts for the extreme degree of heat to which these are brought.

Electricity has often been invoked to produce the most important of all inorganic products, iron. If this problem could ever be solved in an economical way, it would bring about a perfect revolution in the position of the leading nations. On the one hand, the enormous quantity of coal now consumed in the production of iron and steel (which is probably at least a quarter of the entire output of coal) would be set free for other uses, and the exhaustion of the coal-fields would be put off to a corresponding extent. On the other hand, the production of iron would pass over into the hands of those nations which command the largest amount of water-power, and which, therefore, can produce electricity most cheaply. Of the three countries which now produce between them the bulk, that is seven-eighths, of the world's iron, Great Britain and Germany would go to the wall, and the United States, which already produce more iron than these two countries put together, would become omnipotent in that field. Sweden, Italy, and some other countries would, at any rate, greatly increase their present production. But this radical change is, as yet, far off. No proof has, so far, been given that pig-iron, or the ordinary descriptions of wrought-iron and steel, can be generally produced by electricity at anything like the price at which it is now done by coal in the great industrial centres. Where a certain success has been scored in the electrical metallurgy of iron, it is for the refining of ordinary iron into a superior grade of steel which fetches an extraordinarily high price, and in the production of certain alloys of iron with chromium, nickel, and the like, whereby so-called special steels are obtained. But if at the present moment we do not see our blast furnaces and Bessemer works threatened by the competition of electrical iron, who can tell how soon this may not be the case?

The limits of my time have been too nearly reached for me to discourse upon many other problems which present themselves in inorganic applied chemistry, and only a few minutes are left to speak of those belonging to the domain of organic chemistry.

I will point to only two problems of this kind. One of these is the substitution of artificial for natural colouring matters. This, indeed, has now been carried out almost to the bitter end. Long ago, one of the oldest and most widely-used colouring matters, that contained in madder, succumbed to the attacks of the chemists, among whom the names of Edward Schunck and William Henry Perkin testify to the glorious share taken by Englishmen in that victory. The colouring substance of madder—alizarine—is now made from English coal-tar, and has altogether taken the place of the impure form in which it occurs in the madder plant. The growers of this plant in the south of France and elsewhere have had to abandon its culture altogether, to their great sorrow.

A similar fate has already partly overtaken, and may, in the end, destroy entirely, the culture of indigo, most of which, as you know, comes from British India, and formerly represented a value of some four million pounds sterling per annum. At first, after the great Munich chemist, Adolf Baeyer, had prepared the colouring matter of indigo by synthesis in his laboratory, the planters merely shrugged their shoulders, and that with good reason, since Baeyer's processes could not compete with their produce in respect of cost price. Another circumstance which at that time militated against artificial indigo was this, that it started from toluene, the total available quantity of which substance would not have sufficed for producing anything like all the indigo required, even if no toluene were used for other purposes, which is out of the question. But this state of matters has changed. Twelve years ago the late Carl Heumann, assistant professor in my laboratory at Zurich, discovered the synthesis of indigotine from naphthalene. This, like toluene, we get from coal-tar, but in about ten times the quantity, so that there is no fear of any scarcity of naphthalene even in the future. The late Dr. Rudolph Knietsch at the Badische Anilin und Sodafabrik at Ludwigshafen gradually transformed Heumann's laboratory process into a factory process, which is working with entire success on a large scale. Synthetic indigotine is now manufactured at such a low price that its competition has proved a severe blow to the indigo-planting interests. Thus the triumph of scientific investigation and practical skill in chemical manufacturing, gratifying though it be as a splendid achievement of applied chemistry, is a sad trial to many thousands of Indian ryots and their British masters; and this is merely the foretaste of what will inevitably happen in many other cases. What is food for one is poison for another. But yesterday this was the bitter experience of the French madder-grower; to-day it is the turn of the Indian indigo-planter; and to-morrow it may be some one else's lot.

Most other vegetable colouring-matters, several of which have also been synthetically produced, have become useless by the discovery of hundreds, and even thousands, of artificial colouring matters far exceeding them in beauty, and often also in fastness. On this well-known point I cannot dwell now.

In conclusion, I would touch upon what is, perhaps, the very greatest problem of applied chemistry, and that is the direct production of feeding-stuffs for man and beast. The synthesis of alimentary substances from inorganic matter has, up to this moment, not been even remotely achieved, nor can we at present so much as guess the direction in which this might be done; whilst, as for the production of food from sawdust and other waste organic substances, we are in no better case. But even here the word "impossible" should not be pronounced. In a more modest form, at all events, chemistry has found magnificent scope in that quarter—I mean in the extraction of alimentary substances from new sources and in the increase of production from old ones. The colossal industry of beet-root sugar is an instance of the former, whilst agricultural chemistry, as a whole, works in the latter direction.

But this is really too vast a subject to be discussed at the fag-end of this lecture, and I must, therefore, content myself with the foregoing few remarks, and beg to take leave of my esteemed audience.

FOOD ADULTERATION.*

Report of Committee C.—H. C. Lythgoe, *Chairman*.

I. Colours.

It is recommended—

1. That, as suggested by the Associate Referee for 1905, the co-operative work on colours be continued along the following lines:—

a. Solubility of the coal-tar and vegetable dyes in various solvents (ether, acetic ether, petroleum ether, methyl and ethyl alcohols, acetone, &c., and mixtures thereof), arranged according to their solubility—as easily soluble, difficultly soluble, and insoluble,

b. Extractive values of the various solvents for dyes in neutral, acid, and alkaline solutions.

c. Characteristics of the colouring matters as contained in fresh fruits, vegetables, wines, &c., with reagents and solvents, including their respective dyeing properties.

Adopted.

2. It is the sense of the committee that the term "vegetable colours" is a misnomer as applied to the products studied by Mr. Nickles, and the committee recommends that this portion of the report be returned to the Referee with the suggestion that the words "commercial colours alleged to be vegetable colours" be substituted for the words "vegetable colours" and that this portion of the report be revised accordingly.

Adopted.

2. Saccharine Products.

The Referee made no formal recommendations, but suggested that if the work on maple products was continued the three methods tried for the determination of the lead number be given a thorough trial, and that the work on the malic acid value be continued until a modification is secured which gives more uniform results in the hands of different chemists. (Method 1—Winton, *Journ. Am. Chem. Soc.*, 1906, xxviii., 1204. Method 2—Sy, *Journ. Franklin Inst.*, July, 1906, p. 71. Method 3—Hill and Mosher, *Technology Quarterly*, June, 1905, xviii., [2], 147).

No action was taken by the committee on these suggestions, which are submitted for the information of the Referee for 1907.

3. Distilled Liquors.

It is recommended that a further study be made of the determination of fusel oil.

No action taken by committee and recommendation goes to the Referee for consideration.

4. Beer.

The following recommendation was not acted upon by the committee, as it involves action as to an official method, and is referred to the Referee for 1907 for recommendation as to final action, together with the suggestion made as to the revision of the alcoholometric tables:—

I suggest that a committee be appointed by this Association for the purpose of revising the alcoholometric tables now given in *Bulletin* No. 65, that they may be adopted for use at this new temperature (20° C.). I furthermore recommend the adoption of the following methods of beer

* Extracts from the Proceedings of the American Association of Official Agricultural Chemists, 1906.

analysis as official for this Association. (See *Circular* No. 33, Bureau of Chemistry, for detailed statement of methods).

5. Infants' and Invalids' Foods.

It is recommended that the subject "Infants' and Invalids' Foods" be dropped.

Adopted.

6. Condiments other than Spices.

It is recommended that the methods outlined by the Referee be adopted provisionally, but that in printing the same they be given by reference wherever such methods appear under other subjects.

Action deferred for one year.

7. Tea and Coffee.

It is recommended—

1. That the methods outlined by the Referee for the estimation of caffetannic acid be submitted for co-operative study by the members of the Association.

These methods are as follows:—

Bell's or Payen's method, "Chemistry of Foods," vol. i., p. 48; Proctor's modification of Lowenthal's method, Chemistry *Bulletin* No. 13, pt. 7, p. 890; Krug's method, *Ibid.*, p. 908; Trillich and Guckel's method, *Zeit. Nahr. Genussm.*, 1898, p. 101; hydrolytic method, Howard: Boil 5 grms. of coffee one-half hour with 100 cc. of water, and decant the extract through a filter. Repeat this treatment several times and make the filtrate up to 500 cc. Precipitate 200 to 400 cc., equivalent to 2 to 4 grms. of coffee, with lead acetate, wash the precipitate sufficiently to remove the small proportion of sugars present, and submit to hydrolysis by heating in a water-bath with hydrochloric acid. Estimate the reduction sugars by Allihn's method, and calculate to caffetannic acid for both the mono- and di-glucoside formulæ, considering the reducing sugars as $C_6H_{12}O_6$.

Adopted.

2. That the Gomberg method for the determination of caffein be subjected to trial. This method can be logically carried out in connection with the caffetannic acid estimation, and is essentially as follows:—

The filtered extract, prepared by boiling the material with water, is precipitated by lead acetate, and the precipitate filtered off and thoroughly washed with water. The excess of lead is removed from the filtrate by sulphuretted hydrogen, and the latter expelled by boiling. An excess of a standard solution of iodine in potassium iodide is added, the precipitate of the alkaloid with iodine filtered out and the remaining iodine estimated by titration with sodium thiosulphate.

Adopted.

8. Food Preservatives.

It is recommended that the following changes in *Bulletin* No. 65 be made:—

1. Page 109—The second method for the detection of benzoic acid to be re-written as follows:—

Evaporate to dryness and treat the residue with 2 or 3 cc. of concentrated sulphuric acid. Heat until white fumes appear. This chars the organic matter and converts the benzoic acid into sulphobenzoic acid. Add a few crystals of ammonium or potassium nitrate and again heat the dish until white fumes appear. Repeat this process until all organic matter is oxidised and the solution is practically colourless. This causes the formation of metadinitrobenzoic acid. When cool, dilute with an equal volume of water, add ammonia in excess, and transfer the solution to a test tube. Cool and add a few drops of freshly-prepared ammonium sulphide in such a way that the solutions do not mix. The nitro compound is thus converted into ammonium metadinitrobenzoate, which possesses a red colour. This reaction takes place immediately, and is seen at the surface of the liquid without stirring.

2. Page 90, line 2—Substitute "20 cc." for "5 cc." This change is considered advisable, because, when determining sulphurous acid in meat products, about 20 cc. of 20 per cent phosphoric acid is found to be necessary to completely evolve the sulphurous acid present. This amount would not be required for wines, but as there seems to be no objection to the use of the excess of phosphoric acid in this case, it is thought advisable to recommend a uniform quantity of phosphoric acid, which will answer for all purposes.

3. Page 90, after line 34, insert—

Instead of titrating the excess of iodine with the standardised thiosulphate solution, the sulphurous acid distilled over may be determined directly by acidifying the iodine solution, or an aliquot thereof, with hydrochloric acid, boiling until colourless, and precipitating sulphuric acid in the usual way with barium chloride.

4. Page 110, line 41—Transpose the phrase "boiled to expel carbon dioxide," to line 40, inserting the same after the word "pink."

5. Page 110—Under method for boric acid insert the following method:—

Weigh about 50 grms., make alkaline with milk of lime, evaporate to dryness, and ignite as directed under the determination of ash in general methods. Dissolve in hydrochloric acid, filter, and wash. In case much carbon remains, burn the paper and residue after making alkaline with milk of lime, and treat with hydrochloric acid as above. Make the filtrates alkaline with sodium hydroxide, boil, add barium hydroxide until no further precipitate is formed, and filter. Dissolve the precipitate in dilute hydrochloric acid, and re-precipitate with sodium hydroxide, with the addition of a few drops of barium hydroxide. Wash the precipitate with hot water, cool the filtrate and washings to room temperature, and dilute to definite volume. Take an aliquot portion, add methyl-orange, and acidify. Boil to expel carbon dioxide, cool, and add decinormal alkali until the pink colour is just discharged. Add 5 or 6 grms. of mannite and a few drops of phenolphthalein, and titrate the boric acid, which is now all in the free state, with decinormal alkali. When the end point is obtained, it is well to add more mannite, to be sure that enough has been used. Owing to the solubility of barium phosphate, the results obtained by this method should be corrected by a blank determination in which a food free from boric acid is employed. In all cases the operation should be conducted uniformly with respect to volume of solution in which the precipitations are made, and amount of washing.

6. Eliminate from methods for salicylic acid directions to extract the residue with gasolin.

7. Page 73—Eliminate the resorcin method for formaldehyde, inasmuch as this method is unreliable, and there are better methods available.

Action deferred for one year.

It is further recommended that the referee for the ensuing year conduct work along the following lines:—

(1). Quantitative determination of salicylic acid in wines.

(2). Further experiment for the determination of salicylic acid in fruit products, such as jams, marmalades, &c.

(3). Further trial of Harry and Mummery's method (*Analyst*, 1905, xxx., 124).

(4). Trial of method for the detection and determination of fluorides proposed by Woodman and Talbot (*Journ. Am. Chem. Soc.*, xxviii., 1437).

9. Determinanion of Water in Foods.

It is recommended that the study of the vacuum method for the determination of water be continued next year, and that the methods employed for study shall be:—(*a*) The present vacuum method in either the Hempel or Scheibler type of desiccator; (*b*) the vacuum method with any modification which may facilitate drying, as the introduction of phosphorus pentoxide as a drying agent; (*c*) drying in partial vacuum in a current of dry pre-heated air and inert gases.

Adopted.

10. GENERAL RECOMMENDATIONS.

The Committee recommends that the Associate Referees on the following subjects study the determination of alkalinity of soluble and insoluble ash with a view to obtaining uniform results: — Saccharine products, including confectionery; fruit products, wine, beer, vinegar, spices, dairy products (in reference to calcium sucrate in cream), cereal products, vegetables, cocoa and cocoa products, tea and coffee.

Adopted.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

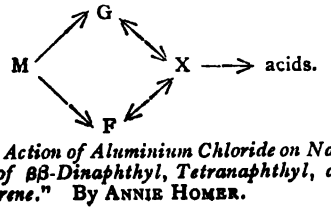
Ordinary Meeting, March 21st, 1907.

Sir HENRY E. ROSCOE, F.R.S., Past President, in the Chair.

(Concluded from p. 164).

66. "*Some Compounds of Guanidine with Sugars.*" (Part I.). By ROBERT SELBY MORRELL and ALBERT ERNEST BELLARS.

When an alcoholic solution of guanidine is added to dextrose, lævulose, mannose, arabinose, rhamnose, galactose, or maltose, dissolved in ethyl alcohol, white microcrystalline precipitates are obtained. The general formula for dextrose-, lævulose-, and mannose-guanidine is $3C_6H_{12}O_6,2CN_3H_5$. In N/2 solutions, the compounds are dissociated into their components to the extent of 71 per cent. The depression of the freezing-points of mixed dextrose and guanidine solutions was determined on the lines of H. Euler's researches (*Ber.*, 1905, xxxviii., 2551; 1906, xxxix., 350), and the results confirm his view as to the acid character of carbohydrates in aqueous solution. The strength of guanidine as a base compared with caustic soda was determined by (*a*) the saponification of ethyl acetate, (*b*) the velocity of fall in rotation angle of a hyoscyamine solution in the presence of guanidine (Will and Bredig, *Ber.*, 1888, xxi., 2777). The strengths of guanidine and caustic soda were found to be in the ratio of 0·8 : 1. Aqueous solutions of dextrose-, lævulose-, or mannose-guanidine show a gradual fall in optical rotation to a minimum value, which is the same for the three compounds. This behaviour is similar to that investigated by Lobry de Bruyn in the action of alkalis on sugars. The results obtained from the study of the mutarotation of solutions of dextrose-, lævulose-, or mannose-guanidine may be summarised as follows:—1. The fall in optical rotation to a constant minimum represents an apparent equilibrium in the case of dextrose- and lævulose-guanidine between two sugars through an intermediate substance, X, the concentration of which is very small, G $\longleftrightarrow$ X $\longleftrightarrow$ F. 2. The velocity constants for the transformation of dextrose into lævulose, and *vice versâ*, were found to be 0·0015 and 0·0021 respectively; the velocity constants for the change of mannose into lævulose and dextrose are 0·0005 and 0·00036 respectively. The velocity of the reverse change of lævulose and dextrose into mannose is very small. 3. There is a slow disappearance of X, the intermediate substance, to form acids. When optical equilibrium has been reached, the ratio of lævulose to dextrose remains constant until the formation of acids ceases. The changes may be represented by the scheme—



67. "*The Action of Aluminium Chloride on Naphthalene. Formation of ββ-Dinaphthyl, Tetranaphthyl, and Tetramethylerythrene.*" By ANNIE HOMER.

The action of aluminium chloride on naphthalene has been studied in detail. $\beta\beta$-Dinaphthyl, $C_{20}H_{14}$, was formed, as had been indicated by Friedel and Crafts. Besides this compound, three new hydrocarbons were isolated, namely:—(1) An oil, $C_{14}H_{16}$, probably *tetramethylnaphthalene*; (2) a resinous hydrocarbon, $C_{26}H_{22}$, to which the name *tetramethylerythrene* has been given; and (3) a yellowish red solid, *tetranaphthyl*, $C_{40}H_{26}$.

Tetramethylerythrene is deep red, and its solutions, besides being highly fluorescent, show two absorption bands in the blue and violet portions of the spectrum respectively.

$\beta\beta$-Dinaphthyl and tetranaphthyl are produced by condensation of the naphthalene molecules. The mode of formation of tetramethylerythrene is open to question.

68. "*Mercurous Hyponitrite.*" By PRAFULLA CHANDRA RAY.

The author has succeeded in preparing this salt in a purer form than that described in a former paper (*Trans.*, 1897, lxxi., 348). A solution of mercurous hyponitrite in nitric acid, unlike the silver salt, undergoes slow dissociation into mercury and mercuric hyponitrite.

69. "*The Decomposition of Mercurous and Silver Hyponitrites by Heat.*" By PRAFULLA CHANDRA RAY and ATUL CHANDRA GANGULI.

The gaseous products of decomposition of mercurous hyponitrites are nitrogen, nitrogen monoxide, and nitrogen dioxide, the proportion of the first being very small.

Silver hyponitrite also yields the same gases with a much larger proportion of nitrogen dioxide. The authors are of opinion that these salts have both an oxylic and imidic constitution.

70. "*Studies in Optical Superposition.*" (Part III.). By THOMAS STEWART PATTERSON and JOHN KAYE.

l-Menthyl diacetyl-*i*-tartrate has been prepared and its rotation has been determined both in the homogeneous state and in solution in ethyl alcohol, benzene, and nitrobenzene. The results, taken in conjunction with those previously published (*Trans.*, 1905, lxxxvii., 33; 1906, lxxxix., 1884), furnish for the first time thoroughly valid evidence as to the untenability of van 't Hoff's assumption regarding optical superposition.

The accompanying table exhibits this comparison at different temperatures for the homogeneous substances, and also gives the values found for solutions (see next page).

Both in the homogeneous condition and in solution therefore the rotation of the *i*-tartrate is markedly greater (that is, less negative) than the means of the values for the *d*- and *l*-tartrates, and this furnishes conclusive evidence that the rotation due to a given asymmetric atom in a compound of two or more asymmetric radicles is not independent of the configuration of the other group or groups with which it is combined.

71. "*An Extension of the Benzoin Synthesis.*" By REGINALD WILLIAM LANE CLARKE and ARTHUR LAPWORTH.

Although mandelonitrile or its benzoyl derivative is too unstable to condense with $\alpha\beta$-unsaturated ketones, yet its aniline derivative, benzylideneaniline hydrocyanide, can be made to do so,

With carvone, *phenylimino-β-benzoyldihydrocarvone is* obtained:—

$$\begin{matrix}NHPh\\CN\end{matrix}\!\!>\!CHPh + CH\!\!<\!\!\begin{matrix}CMe\cdots\\C_6H_{10}\end{matrix}\!\!>\!CO =$$

$$= NPh{:}CPh{\cdot}CH\!<\!\!\begin{matrix}CHMe\\C_6H_{10}\end{matrix}\!\!>\!CO + HCN,$$

and this, on hydrolysis with acids, yields two stereoisomeric *β-benzoyldihydrocarvones*.

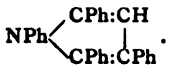
With benzylideneacetophenone, *γ-cyano-α-benzoyl-γ-anilino-βγ-diphenylpropane* is the product:—

$$\begin{matrix}NHPh\\CN\end{matrix}\!\!>\!CHPh + CHPh{:}CH{\cdot}CO{\cdot}Ph =$$

$$= \begin{matrix}NHPh\\CN\end{matrix}\!\!>\!CPh{\cdot}CHPh{\cdot}CH_2{\cdot}CO{\cdot}Ph,$$

		I. *l*-Menthyl diacetyl-*d* tartrate.	II. *l*-Menthyl diacetyl-*l*-tartrate.	III. Mean of I. and II.	IV. *l*-Menthyl diacetyl-*i*-tartrate.	Δ. IV.—III.
			Homogeneous Substances.			
$t°$	20°	−256°	−360°	−308°	−274°	34°
	100°	228	382	305	280	25
	130°	216	390	303	282	21
			Solutions.			
Solvent	Ethyl alcohol	−268° (p : 5)	−367° (p : 5)	−317·5	−292° (p : 0·455)	25·5°
	Benzene	285 „	313 „	299·0	248 (p : 5·2)	51·0
	Nitrobenzene	238 „	355 „	296·5	244 (p : 4·38)	52·5

the constitution of which was shown by converting it by heat into water, hydrogen cyanide, and tetraphenylpyrrole,



In neither instance does benzylideneaniline alone afford any analogous products. These condensations were shown to be extensions of the well known "benzoin synthesis" as interpreted by one of the authors (*Trans.*, 1903, lxxxiii., 1004).

72. "*Interaction of Starch and Carbon Disulphide. Xanthogenic Esters of Starch.*" By CHARLES FREDERICK CROSS, EDWARD JOHN BEVAN, and JOHN FREDERICK BRIGGS.

Alkali starch in its hydrated forms is a gelatinous impenetrable mass which is only superficially attacked by carbon disulphide.

Starch moistened with the disulphide and then treated with a sodium hydroxide solution (15 to 20 per cent) is brought into the condition for quantitative reaction and conversion into the xanthogenic ester (sodium salt). The derivatives are analogous in all respects to those of cellulose (*Trans.*, 1893, lxiii., 837).

73. "*The Estimation of Small Quantities of Nitrogen Peroxide.*" By ROBERT ROBERTSON and SIDNEY SCRIVENER NAPPER.

The method depends on the changes observed in the characteristic absorption spectrum of nitrogen peroxide as its concentration in dilute mixtures is increased. It was found that a few of the more prominent groups of lines were visible at a concentration of 0·05 per cent nitrogen peroxide, and that as the proportion was raised the lines increased in intensity and number until the violet end of the spectrum was completely absorbed in mixtures approaching a concentration of 1·0 per cent. These differences are sufficiently well marked to enable a process to be worked out for the quantitative estimation of the concentration by comparison with standard mixtures. Photographic comparison was employed, and for this purpose a series of standard photographs covering a range of concentration from 0·05 to 1 per cent was prepared.

The method when applied to the estimation of small quantities of nitrogen peroxide in air gives very satisfactory results, and the process which is applicable to any gaseous mixture has been used successfully for the investigation of the gases evolved during the slow decomposition of gun-cotton.

74. "*The Evolution of Nitrogen Peroxide in the Decomposition of Gun-cotton.*" By ROBERT ROBERTSON and SIDNEY SCRIVENER NAPPER.

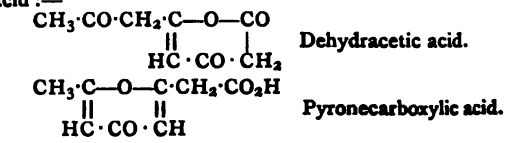
Previous investigators have given accounts of experiments in which gun-cotton was slowly decomposed at temperatures near 130° in a vacuum and in a current of carbon dioxide, and have stated that only a small quantity of nitrogen peroxide was evolved, or have made no reference to its presence. With the help of the method described by the authors (compare preceding paper) a careful study has been made of the gases given off by gun-cotton when heated under various conditions.

These include heating (1) in a vacuum; (2) in a stream of carbon dioxide; (3) in an unchanged atmosphere of carbon dioxide; (4) in nitrogen dioxide; and (5) in air. In all cases more than 10 per cent of the total nitrogen evolved was in the form of nitrogen peroxide, and a study of the results shows that the proportion is largely dependent on the conditions of experiment; the deposition of water and prolonged contact with the heated gun-cotton tend to reduce it, and when these two conditions are not present the proportion rises to 40—50 per cent. This occurs when the gun-cotton is heated under the conditions of the Will test, and reduction of the rate of the current of carbon dioxide causes a reduction of the proportion of nitrogen peroxide evolved. This effect is apparently due to the action of the nitrogen peroxide on the gun-cotton, and is accompanied by a rise in the total amount of nitrogen evolved, indicating that oxides of nitrogen cause an increase in the rate of decomposition of gun-cotton.

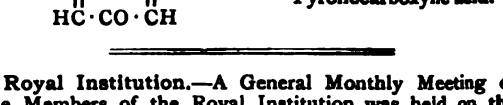
75. "*An Isomeric Change of Dehydracetic Acid.*" By JOHN NORMAN COLLIE and THOMAS PERCY HILDITCH.

During the preparation of a large quantity of triacetic lactone, it has been noticed that if sulphuric acid of about 85 per cent instead of about 90 per cent is allowed to act on dehydracetic acid, the yield of triacetic lactone is much diminished. On pouring the product into water, an acid, $C_8H_8O_4$, isomeric with dehydracetic acid, has been separated. It has a molecular weight of 169, is a true acid, not a lactone, melts at 99°, and has an electrical conductivity $k = 0·00152$. When heated to about 200° it is converted almost quantitatively into carbon dioxide and dimethylpyrone. On boiling with excess of strong solution of barium hydroxide it yields barium acetate, acetone, and barium malonate. A solution of the neutral sodium salt on boiling is converted into sodium dehydracetate, from which dehydracetic acid is precipitated by adding an acid.

The free acid, when heated with an excess of ammonia, gives the ammonium salt of a lutidonecarboxylic acid. This acid, $C_8H_8O_4$, seems to agree in all respects, except its electrical conductivity, with an acid obtained by Feist (*Annalen*, 1890, cclvii., 253), and is a true pyronecarboxylic acid:—



Dehydracetic acid.



Pyronecarboxylic acid.

Royal Institution.—A General Monthly Meeting of the Members of the Royal Institution was held on the 8th inst.; Sir James Crichton-Browne, M.D., F.R.S., Treasurer and Vice-President, in the Chair. Mr. E. T. Hanson, Mrs. H. Loeffler, Sir Alexander Pedler, C.I.E., Dr. J. Percy Smith, Mr. F. H. Sully, Mr. A. H. Tubby, F.R.C.S., and Mr. C. A. Woods were elected Members. The Special Thanks of the Members were returned to Sir Andrew Noble, Bart., K.C.B., for his donation of £200 to the Fund for the Promotion of Experimental Research at Low Temperatures; and to Lady Kelvin for her Gift of a Statuette of the Rt. Hon. Lord Kelvin, G.C.V.O. The Chairman announced the decease of Professor M. Berthelot, Hon.Mem.R.I., and of Dr. Allen Macfadyen, Fullerian Professor of Physiology in the Royal Institution 1901-3, and Resolutions of condolence with the relatives were passed.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft.
Vol. xl., No. 3, 1907.

Isomeric Cinnamic Acids.—E. Erlenmeyer, jun., C. Barkow, and O. Herz.—The authors have subjected the isomeric cinnamic acids to a crystallographic examination, and find that the different modifications can be distinguished from one another by their forms, and also that they have different melting-points and different solubilities. The acids are—(I.) Erlenmeyer's (sen.) isocinnamic acid, melting-point 37—38°; (II.) Liebermann's allocinnamic acid, melting-point 68°; (III.) Liebermann's isocinnamic acid, melting-point 59°; (IV.) α-cinnamic acid, melting-point 134—135°; (V.) β-cinnamic acid, melting-point 132—133°; (VI.) Erlenmeyer's (jun.) isocinnamic acid, melting-point 59°. Storax cinnamic acid and synthetic cinnamic acid differ in crystalline form and in solubility. The author's experiments with brucin show that the allocinnamic acid disappears when a salt is formed, and two salts of the same composition, but different properties and different rotatory powers, result. From them the Acids III. and VI. can be isolated, but under certain conditions transpositions of the salts are very probable, and when the acids are set free transpositions likewise may occur.

Preparation of Optically Active Butyl Alcohol.—R. Meth.—A convenient and rapid method of splitting racemic alcohols into their active components is the following:—Butyl alcohol is mixed gradually with three-fifths of its volume of concentrated sulphuric acid, meanwhile cooling; the mixture is allowed to stand for a day at the temperature of the room, and then poured into a suspension of barium carbonate in water. The filtrate is evaporated, which causes some decomposition, and finally, after repeated filtration, evaporated over sulphuric acid. The yield of crystalline barium butyl sulphate amounts to 18 or 19 grms. from 20 cc. of alcohol, thus roughly 35 per cent. The salt is exceedingly soluble in water, but can be re-crystallised from a little hot water. The barium salt is dissolved in water, the calculated quantity of brucin sulphate is added, the solution is filtered from barium sulphate and evaporated. After standing over-night the salt of the dextro-acid separates out as crystals, and can be purified by re-crystallisation from acetone or a little hot water. It melts at 210°, undergoing decomposition. The brucin salt of the lævo-acid also crystallises, but the separation of the two salts does not present the least difficulty. The brucin salt was again converted into barium salt and its rotatory power determined in aqueous solution, and compared with the rotatory power of the crystals first obtained by the evaporation of this solution. The two values agreed within the limits of errors of observation, and thus the separation of the brucin salts was complete.

Abnormally Coloured Complex Metallic Salts of Acid Imides.—H. Ley and F. Werner.—The authors' experiments provide a striking illustration of the fact that when side valencies are called into action the characteristic light absorption of a coloured salt is often totally changed. Thus copper succinimide, $Cu(NC_4O_2H_4)_2.6H_2O$, is blue, but the complex salts, $Me_2Cu(NR)_4$ (where Me = alkali metal and HNR = acid imide), prepared by the action of copper acetate on the alkali salts of the acid imide, are red or violet-red. Copper succinimide, $Cu{<}^{NR}_{NR}$, contains a metallic nitrogen bond, which causes no abnormal absorption of light; if, however, the other valencies of the metal are called into action, as in $^{NH_3}_{NH_3}{>}Cu{<}^{NR}_{NR}$, such abnormal absorption occurs, and the compounds become red or reddish brown, while the complex salt, $\left(^{RN}_{RN}{>}Cu{<}^{NR}_{NR}\right)Me_2$, is violet. Hence, it may be assumed that the change of light absorption which occurs when a simple salt (ion) is converted into a complex salt (complex ion) is connected with the increase of volume. The red violet-coloration which cyanuric acid gives in alkaline solution with cupric salts, which resembles the typical biuret reaction, is also dependent upon the formation of a complex copper alkali cyanurate, which has a constitution similar to that of the copper acid imide complex.

MISCELLANEOUS.

"Allen's Commercial Organic Analysis."—The Third Edition of Vol. II., Part 3, of this work is just ready for publication. The subjects dealt with are:—Acid Derivatives of Phenols, Aromatic Acids, Resins and Essential Oils. Much of the work of revision has been done by Mr. A. R. Tankard, F.C.S., Deputy Agricultural Analyst for Monmouthshire and the County Borough of Newport. With its issue the complete work in eight volumes may now be procured. The publishers are Messrs. J. and A. Churchill.

The Chemical Laboratory at Wiesbaden.—During the Winter Term, 1906-7, the Chemical Laboratory Fresenius was attended by 40 students. Of these, 27 were from Germany, 5 from England, 2 from Holland, 1 from France, 1 from Norway, 1 from Spain, 1 from the United States of America, 1 from Brazil, and 1 from East India, There were three assistants in the Instruction Laboratory, and twenty-three in the Versuchsstationen (private laboratories). To the certified staff of teachers belong the Directors, Geh. Regierungsrat, Prof. Dr. H. Fresenius, Prof. Dr. W. Fresenius, Prof. Dr. E. Hintz, and also Prof. Dr. med. G. Frank, Dr. L. Grünhut, Dr. R. Fresenius, and J. Huber (Architect). The next Summer Term begins on April 24th. During the Winter Term, 1906-7, besides the scientific researches, a great number of analyses were undertaken in the different departments of the Laboratory (Versuchsstationen) on behalf of trade, manufacture, mining, agriculture, hygiene, justice, and government.

NOTES AND QUERIES.

"*" Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertisement columns.

Non-inflammable Alcohol.—Can any reader inform me if alcohol can be made non-inflammable? The liquid so treated is not intended for human consumption.—ALCOHOL.

MEETINGS FOR THE WEEK.

MONDAY, 15th.—Society of Arts, 8. (Cantor Lectures). "Detergents and Bleaching Agents used in Laundry Work," by Prof. Herbert Jackson, F.I.C., &c.

TUESDAY, 16th.—Royal Institution, 3. "Wings and Aeroplanes," by Prof. G. H. Bryan, F.R.S., &c.

—— Society of Arts, 8. "Joinery and Furniture Making," by A. Romney Green.

WEDNESDAY, 17th.—Society of Arts, 8. "Aërial Navigation," by Major B. F. S. Baden-Powell.

—— Microscopical, 8. "The Podura Scale," by E. M. Nelson. Exhibition of Slides of Foraminifera, by A. Earland.

THURSDAY, 18th.—Royal Institution, 3. "The Birth and Affinities of Crystals," by Prof. H. A. Miers, F.R.S., &c.

FRIDAY, 19th.—Royal Institution, 9. "Nerve as a Master of Muscle," by Prof. C. S. Sherrington, F.R.S.

SATURDAY, 20th.—Royal Institution, 3. (The Tyndall Lectures). "Studies in Magnetism," by Prof. Silvanus P. Thompson, F.R.S.

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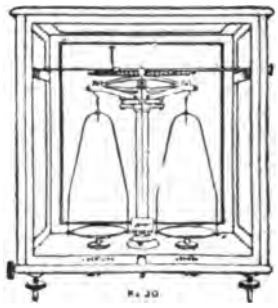

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THE CHEMICAL NEWS.

VOL. XCV., No. 2473.

A NEW METHOD FOR THE SEPARATION OF THE YTTRIUM EARTHS.

By C. JAMES, A.I.C.

IN working up a specimen of gadolinite for the rare earths the remarkable fact was noted that the filtrate, after the beryllium separation by ammonium carbonate, contained a small quantity of rare earth oxalate, and that the nitrates obtained therefrom gave absorption bands which were very intense for erbium, while the holmium and dysprosium bands had grown very faint. The insoluble oxalates, which had been previously removed in the usual manner after conversion into the nitrates, presented the ordinary absorption spectrum of erbium, holmium, dysprosium, &c. It was at once apparent that either erbium oxalate was more soluble in beryllium oxalate, or else traces of the rare earth oxalates were thrown down by the ammonium hydroxide, re-dissolved in ammonium carbonate, and fractionated by means of heat. On boiling some of the oxalate material with a very concentrated solution of beryllium oxalate, it was found that the filtrate contained no erbium. The only alternative was that the fractionation was due to the ammonium carbonate.

Method of Separation.

Having determined by further experiment that the yttrium group oxalates were very soluble in ammonium carbonate, a careful search for the conditions bearing upon the separation was made, and the following method of procedure was found to give the best results:—

The oxalates freed from those earths giving insoluble double sodium sulphates are treated with a solution of ammonium carbonate made by saturating dilute (1 to 5) ammonium hydroxide with the solid salt. The whole is then well stirred, and the beaker placed in a water-bath; on warming, the whole enters into solution, forming a reddish yellow liquid. The temperature of the bath is then raised to boiling, when a precipitate soon appears. This is filtered off, and the filtrate re-treated in the same manner, and some five fractions thus obtained of approximately equal size.

Usually after the first two fractions have been taken the liquid rapidly loses carbon dioxide; although sometimes the ammonium carbonate begins to decompose even before the first precipitate forms.

The oxalate should be fresh and moist so as to easily mix up, and not contain more than traces of the cerium metals, for otherwise complete solution will not be obtained. After a little practice one is able to add just about the right amount of ammonium carbonate to dissolve the mixed oxalates, and thus avoid waste of this rather expensive reagent.

While the precipitates are forming the liquid should be well stirred so that the temperature is even throughout the mass; this applies specially to Fractions I. and II.

Results of Fractionation.

Fraction I. soon formed, and consisted of a crystalline powder with a faint pink tinge. One portion on igniting gave a yellowish oxide, and another on treatment with hydrochloric acid dissolved entirely with strong effervescence. The solution gave faint traces of the bands of didymium, the holmium and dysprosium bands were stronger than the erbium, but all the bands were weaker, showing a great increase in the percentage of yttrium. This first fraction consisted simply of carbonates.

Fraction II. appeared to be similar to Fraction I., except that it possessed more of a pink colour. The oxide was yellow, and original precipitate was again entirely soluble in hydrochloric acid. The solution gave no didymium absorption bands, while those of holmium, dysprosium, and erbium were stronger, and when compared with a solution of the gadolinite oxides it was seen that holmium and dysprosium had increased and erbium decreased.

Fraction III. took longer to form, and was heavier, of a rose colour, and was not entirely soluble in hydrochloric acid; so at this stage oxalates were being precipitated also. On ignition it gave a yellowish oxide, and the absorption bands of the solution were very much the same as the original material.

Fraction IV. required a considerable time to deposit, and was of a salmon colour. On heating, it gave a light coloured oxide with a faint yellow tinge, which, on dissolving in nitric acid, gave a very intense erbium spectrum; that of holmium and dysprosium had become weak.

Fraction V. obtained by evaporation to dryness and calcining gave a very dense oxide of a pink colour. It was soluble in strong nitric acid after heating for some time on the water-bath, giving a fine rose-coloured solution presenting an intense erbium spectrum, holmium and dysprosium being very weak.

This last fraction, usually smaller than the others, was converted into the oxalate, and again submitted to fractionation.

Fraction *a*. Coloured rose.
" *b*. Coloured salmon.
" *c*. Coloured delicate salmon.

The resulting oxide had a rose colour, which on being treated with nitric acid gave a very concentrated solution with only faint bands of holmium and dysprosium.

Fraction *d*, evaporated to dryness and ignited, gave a white oxide with a pink tinge.

This fraction was practically free from holmium and dysprosium. It gave erbium bands and also a thulium band in the red, and contained a fair amount of ytterbium and some thorium.

It will be seen by the above that the earths separate in the following order:—

Cerium group—yttrium, terbium—dysprosium, holmium—erbium—thulium—ytterbium.

Yttrium oxide was separated from the first fractions by the method of Muthmann and Rolig (*Ber.*, xxxi., 1718) as follows:—

The precipitate consisting chiefly of carbonate of yttrium was ignited, dissolved in nitric acid, the concentrated solution boiled, and a thick cream of magnesium oxide added until the liquid no longer gave absorption bands.

This well known method gives good results, although Dennis and Dales (*Journ. Am. Chem. Soc.*, xxiv., 428) were not successful in getting good separations by its aid. Their trouble undoubtedly lay in the fact that they employed the chlorides instead of the nitrates as recommended by Muthmann and Rolig.

While this method separates erbium, holmium, and dysprosium from yttrium, terbium clings, and for the final purification the chromate method of Muthmann and Böhm (*Ber.*, xxxiii., 49; CHEMICAL NEWS, lxxxi., 169) was employed, and a pure white yttria was easily obtained. The material separated from the major portion of the yttria by the above methods was again converted into oxalates and fractionated from ammonium carbonate solution.

It is always advisable to treat the oxides from minerals very rich in yttria by the above methods in order to remove the great excess of this earth before proceeding with the fractionation.

It will be seen that the "oxalocarbonate" method gives excellent results, the separation especially of pure erbium from holmium, dysprosium, and terbium being accomplished in a much shorter time than by any other known

method. The fractionation of holmium, dysprosium, and terbium is much slower than that of erbium, thulium, and ytterbium, the two last being found in the most soluble fractions.

Another advantage of this procedure lies in the fact that the last fraction is evaporated to dryness, and so no soluble elements are washed away as is the case where dilute solutions are employed.

This method has also been applied to some monazite residues which were on hand, and which were rich in terbium, holmium, and dysprosium, and contained besides erbium, yttrium, traces of samarium, and gadolinium. As before, the oxalates were very soluble, and gave dense precipitates, but the separation was not so immediate and complete as in the case of the gadolinite oxalates.

The colour of the oxides varied from orange-brown to pale yellow, the latter coming from the most soluble portion. In all of these separations it is highly important that in comparing fractions by colour and by the absorption spectrum the same acid be used as solvent, for otherwise erroneous conclusions may be reached owing to the colour and spectra varying in different compounds.

Complexity of Erbium.

One of the interesting and important results of this method of separation is the fact that the material known as erbium is in all probability complex, as was found to be the case with didymium. Differences in the absorption spectra of erbium from different sources are noticeable, and while it is too early to give any detailed description of the changes observed, it does seem well to call the attention of chemists working on the rare earths to this peculiarity. A considerable amount of gadolinite and xenotime is now being worked up and separated for purposes of future research.

In conclusion, I wish to thank Professor Charles L. Parsons for advice and the interest he is taking in the work, and acknowledge my indebtedness to the Welsbach Light Company for raw material received, through the courtesy of Dr. H. S. Miner.

New Hampshire College, Durham, N.H.
January 10th, 1907.

NOTE.—At the present time the author is investigating the bromates of the rare earths, which vary greatly as regards their solubility in water. After a few series of crystallisations of the bromates of yttrium, terbium, holmium, dysprosium, and erbium the least soluble crystals become white and the most soluble rose, while the intermediate are yellow. This together with the absorption spectra show that yttrium is the least soluble, while holmium and dysprosium come next, and then erbium, &c.

A paper will be published shortly giving the solubilities and other properties of these compounds together with the results of the fractionation of a large amount of material.

THE FRUIT OF *SMILACINA RACEMOSA* AND *BIFOLIA*.

By C. G. ELDREDGE and L. M. LIDDLE.

THE fruit of the *Smilacina racemosa* was gathered at Sylvan Beach, New York, on the shores of Oneida Lake, August 6th to 20th, 1906. The soil is composed very largely of sand, upon which is found a second growth of forest trees and shrubs. The region is not adapted to purposes of agriculture on account of the sandy character of the soil. The whole territory, comprising several square miles. was formerly the lake bottom at the period when the water was discharged through the Mohawk and Hudson Rivers. An elevation of the land took place by which the lake was projected farther north, and the water has since been discharged through the Oneida and Oswego rivers into Lake Ontario.

The fruit consists of berries which are borne on a racemose panicle. Most of them were gathered on August 6th while still green, because it was noticed that as they ripened the birds and fowls ate them, and many fell upon the ground and were lost. When first gathered, they were spherical in shape, green in colour with reddish stripes, somewhat of a pearly lustre, and about as large as medium size peas. They were picked attached to the upper portion of the stalk, and allowed to ripen slowly in the house. When ripened in this way or allowed to mature naturally, they possess a bright red appearance, and resemble currants. If the berries are kept for two or three hours in the air-bath at 110—120°, they assume the red appearance, and resemble the fruit that has come to its natural maturity. Three months after gathering, the berries weighed one-fifteenth of a grm. each; while those that had been secured the year before, after fifteen months, weighed one-twentieth of a grm. Each berry contains a relatively large nutlet of oily or resinous appearance. While this species is in general widely distributed, at Sylvan Beach the plants are restricted to a narrow area.

The Pulp.—There were on hand for this investigation 372 grms. of the air-dried fruit. We crushed 186 grms. in an ordinary meat grinder, which cut the husks and fleshy part of the berries and broke only a few of the nutlets.

The ground berries were placed in a 500 cc. flask which was fitted with an inverted condenser, and treated for three or four days on a warm water-bath until all colour was removed. Eight or ten successive portions of alcohol were required. The red extract was transferred to a larger flask, and the alcohol removed by distillation. The last 400 cc. of the distillate had a fragrant nut odour similar to that of the syrupy mass left in the flask.

A second portion of the uncrushed fruit was subjected to the alcoholic treatment with equally satisfactory results. The husks and nutlets were separated by placing them in water after the alcoholic extraction, and rolling them between the hands. This separated the nutlet from the rest of the berry, and allowed the lighter portions to be washed away in a manner similar to that of "panning."

A portion of the berries was treated with water, but this failed to remove the colouring matter and sugar as satisfactorily as did the alcohol.

A portion of the syrup in alcoholic solution was treated with a relatively large amount of purified bone-black for twenty-four hours on the water-bath, when it lost nearly all of its colour. This solution was afterwards used in testing for acids, salts, and the character of the sugars.

By holding one of the berries on platinum-wire in the flame, the characteristic colour of potassium was plainly visible. The same reaction was obtained by subjecting some of the thick syrup to a similar test.

We placed 2·175 grms. of the berry husks in a small platinum evaporating dish. On gently igniting these, a decided odour of scorched squash or pumpkin was discernible, which increased with the rise in temperature. The ash from the amount used weighed 0·03 of a grm. When a few drops of dilute hydrochloric acid were added to the residue, there was a brisk effervescence, probably from an original oxalate. The insoluble portion was filtered off, and to the filtrate were added a little alcohol and a few drops of a 10 per cent solution of platinic chloride. A microscopical examination showed the crystals to be octahedral in form. There was also a small quantity of iron in the ash. The filtrate from the potassium platinic chloride, after removing the excess of platinic chloride and treating with ammonia and ammonium oxalate, gave a white precipitate of calcium oxalate. The presence of this precipitate was confirmed in the usual way. The clear filtrate from the bone-black was tested for tartaric and oxalic acids. Both were found, and their presence was confirmed by several tests. Malic and citric acids seemed to be absent. As the alcoholic extract showed a strong acid reaction, the oxalates and tartrates doubtless exist in the form of the acid potassium salts. A trace of tannic acid was found. Of the two bases, calcium and

potassium, that were shown to be present, potassium exists in relatively greater quantities.

Sugars.—A portion of the filtrate from the bone-black was evaporated to dryness on the water-bath with constant stirring. 0·2 grm. portions were weighed out, and treated according to Sherman and Williams (*Journ. Am. Chem. Soc.*, May, 1906, xxviii., 629). The time of the first three trials, one and a-half, one and a-half, and one and a-quarter minutes, corresponds to fructose. Portions of 0·1 grm., 0·05, 0·01, and 0·005 were similarly tested and likewise shown to be fructose. The osazone was filtered off and purified by repeated crystallisations from alcohol. It melted at 204—205°, which is the melting-point of both dextrose and lævulose. A microscopical examination of the crystals showed their identity with the osazone of the sugar found in urine. The time of the osazone formation of a large number of samples of the sugar was noted, all of which showed it to be fructose, or at least chiefly lævulose. The sugar is deliquescent, returning to a thick syrup on exposure to the air for a short time. That which was extracted by the water had an odour and taste similar to New Orleans molasses. The taste became astringent and bitter after the sugar had remained in the mouth a short time.

The Nutlets.—After removing the husks and the fleshy portion as indicated in the foregoing, the nutlets were dried in the oven. 186 grms. of the berries gave 55 grms. of the dried nutlets. These were very hard and tough, and could not be ground in a coffee mill or meat grinder. A heavy iron mortar and pestle could make no impression upon them. Finally, recourse was had to a rock crusher. By passing them through this ten or twelve times, a moderately fine powder resulted.

The crushed nutlets were placed in a Soxhlet extractor, and treated with ether. The finer portions of the powder persistently stopped up the syphon of the apparatus, so the whole was finally transferred to a 250 cc. flask fitted with an inverted condenser. The treatment was continued for seventy-two hours. This gave a light yellow liquid, and on distilling off the ether there remained a substance which on standing separated into a liquid and solid oil; only about 10 cc. of both were obtained. On placing them in a freezing mixture, no change was observed. They were then saponified by an alcoholic solution of caustic potash. The resulting soap was dissolved in water and decomposed with dilute hydrochloric acid. After crystallising from alcohol, a microscopical examination showed the presence of palmitic acid imbedded in a matrix of unchanged oil. Crystallisation from ether was no more satisfactory than from alcohol. Judging from the physical characteristics, the oils seemed to be palmitin and olein.

The residue of the nutlets from the ether extraction was dried, and then treated as were previously the whole berries with alcohol. After the alcohol was distilled off, there remained another portion of sugar. This on stirring crystallised readily, and by subsequent tests proved to be fructose. This sugar in small quantities had a taste resembling horehound candy, becoming bitter and astringent after remaining a short time in the mouth. The melting-point of the pure sugar was found to be 95°, which indicated that it was fructose.

The Ripened Fruit.—In Eastern Iowa, near the highway between Mount Vernon and Marion, on September 25, 1906, some of the fully ripened fruit was found still on the stalks. It seemed an interesting experiment to compare the berries developed naturally to full maturity with those which were picked quite green and allowed to ripen slowly like bananas on the stems. There were found to be 200 grms. available for this part of the work. Their weight corresponded with those of the earlier picking; each one-fifteenth of a grm.

These were treated with the same solvents, the pulp with alcohol and the crushed nutlets with ether, as the other fruit, and they gave the same substances with one additional, tannic acid. The presence of this was distinctly shown in the pulp by a number of tests. It seems quite probable that the tannin exists in the green berries in the form of a glucoside, which changes into the acid as the fruit ripens under normal conditions.

Smilacina Bifolia.

These were gathered at Sylvan Beach from September 10 to 30, 1906. They are much more widely distributed in that region than the *racemosa*. 400 grms. of the air-dried fruit were at hand. The berries are much smaller than those of the other species, averaging one-twenty-eighth of a grm. in weight.

The nutlets were equal in hardness and toughness to the *racemosa*, and yielded only to the persistent use of the ore crusher. The same acids, bases, and oils were found in this as in the other species.

Substances Found.

Acid potassium tartrate, acid potassium oxalate, tannic acid in the ripened fruit of both species.

A small amount of calcium oxalate in the husks. Fructose with possibly a little glucose in the husks and the fleshy part of the berries. Pure fructose in the nutlets. Olein and palmitin.

A small amount of gum in both species.

The berries of both species seem to possess the same general properties.

We desire to express our thanks to Dr. N. Knight for advice and assistance in this work.

Chemical Laboratory, Cornell College,
March 27, 1907.

A STUDY OF THE METHODS FOR THE DETERMINATION OF ESTERS, ALDEHYDES, AND FURFURAL IN WHISKY.*

By L. M. TOLMAN and T. C. TRESCOT.

IN the course of an examination of a large number of whiskies made in the U.S. Bureau of Chemistry under the direction of H. W. Wiley, the following work on the methods for the determination of the ethereal salts, aldehydes, and furfural was undertaken, as the methods adopted provisionally by the Association of Official Agricultural Chemists, as published in *Bulletin* 65 of the Bureau of Chemistry were found to be unsatisfactory.

DETERMINATION OF ESTERS.

The provisional method as adopted by the Association of Official Agricultural Chemists in 1903 for the determination of esters is as follows:—

Neutralise the residue left after distillation in the fusel oil determination with N/10 sulphuric acid and add an excess of 10 cc. of the acid. Allow to stand five minutes and make up to 200 cc. Titrate two portions of 25 cc. each, using as indicators methyl-orange in the first and phenolphthalein in the second. The difference gives the amount of alkali necessary to neutralise the organic acids in 25 cc. of the sample. By subtracting from this figure the number of cubic centimetres of alkali required for the free acids and multiplying the result by 0·0088, the number of grms. of ethereal salts (calculated as ethyl acetate) in 25 cc. of the sample is determined.

The distillation of fusel oil is conducted as follows:—Add a small quantity of alkali to 200 cc. of the sample under examination, and distil slowly, till about 175 cc. have passed over; allow the distilling flask to cool, add 25 cc. of water, and distil again till the total distillate measures 200 cc. It was found, however, that it was exceedingly difficult to carry out this method satisfactorily, and, further, that it was very inaccurate, not in reality giving any true ester value.

* From the *Journal of the American Chemical Society*, xxviii. No. 11.

The first objection is that the method does not state that sufficient alkali must be added in the distillation to completely neutralise the acids and saponify the esters. If this is not done, there is a loss of unsaponified esters. Some of the whiskies required as much as 10 cc. of normal alkali to 200 cc. to accomplish this result.

The second objection is the difficulty experienced in the double titration with methyl-orange and phenolphthalein in the dark coloured whiskies, it being practically impossible to get two titrations agreeing within a reasonable limit of accuracy. It was also found that there is a considerable loss of volatile esters, which come over in the first part of the distillate before they are saponified, even though there be sufficient alkali present, and it was found necessary to boil with a reflux condenser before beginning the distillation. The chief source of error, however, is in the action of the alkali on the caramel and invert sugar present in the whisky.

How much this error may amount to is shown in Table I., where caramel prepared from pure cane-sugar was treated in the following manner :—A weighed amount of caramel is placed in an Erlenmeyer flask and dissolved in 50 cc. of alcohol (50 per cent by volume). This is exactly neutralised with N/10 alkali, using phenolphthalein as an indicator, and then 10 cc. of N 10 alkali are added, the flask connected with a reflux condenser, and boiled for one hour, then cooled, and the excess of alkali titrated.

Table I. shows that, with 0·500 grm. of caramel per 100 cc., which gives a colour about equal to a dark coloured whisky, we would have 7·6 cc. N/10 alkali used up by the caramel, which would be calculated as esters. This would be as much as the volatile esters in most whiskies. If, however, there was also invert sugar present, a still larger error would be introduced, as is shown in Table II.

Table II. shows that invert sugar uses up the alkali to a greater degree than caramel. If this reaction of alkali with caramel and invert sugar were quantitative, the figure might have some value, but it is not, so that such a determination can have no value in the presence of these substances.

An illustration of this fact is shown in the results on some brandies (Table III.).

Table III. shows that the fixed esters increase with the sugar, and are, in fact, dependent upon its presence. If it were not for this fact the determination of fixed esters might be of some value, as the accompanying table on pure whiskies indicates (Table IV.).

It was evident from this work that the provisional method is unsatisfactory, and does not give an ester number. It was therefore necessary to determine the esters in a distillate which was prepared in the following manner :—Add 25 cc. of water to 200 cc. of the whisky or spirit to be examined and distil off 200 cc. into a flask guarded with a mercury valve to prevent loss of alcohol. Measure 50 to 100 cc. of this distillate into a flask, add a few drops of phenolphthalein, and exactly neutralise the free acid with N/10 alkali: add 25 to 50 cc. of N/10 alkali, stopper the flask, and allow to stand at room temperature for eighteen to twenty hours, then connect with a single tube condenser and heat nearly to boiling for one-half hour, cool, and titrate the excess of alkali with N/10 acid.

The number of cubic centimetres of N/10 alkali used in the saponification multiplied by the factor 0·0088 gives the amount of esters present as ethyl acetate. There should be a considerable excess of alkali to ensure the saponification being complete.

The esters may also be determined by connecting the flask with a reflux condenser, instead of allowing them to stand over night, and boiling for one hour, and if only a few determinations are to be made this will be found to be the most satisfactory procedure, but where a large number of determinations are to be made the first scheme is very satisfactory. It was found by experiment that standing over night with the excess of alkali ensured complete saponification of the esters without any danger of loss of the volatile esters.

TABLE I.—*Effect of Alkali on Caramel.*

Caramel.	Amount of N/10 alkali used up.	Time of boiling.
Grm.	Cc.	Hours.
0·050	0·70	1
0·100	1·85	1
0·150	2·70	1
0·200	3·60	1
0·250	3·80	1
0·250	4·60	2

TABLE II.—*Effect of Invert Sugar on the Alkali.*

Invert sugar.	Amount of N/10 alkali neutralised.	Time of boiling
Grm.	Cc.	Hours.
0·059	1·2	1
0·050	1·5	2
0·100	2·9	1
0·150	3·6	1
0·250	5·85	1
0·250	6·95	3

TABLE III.—*Relation of the Solids and Invert Sugar to the Fixed Esters.*

Solids.	Invert sugar.	Amount of N/10 alkali used by 100 cc.	Amount of N/10 alkali used by volatile esters in 100 cc.	Amount of N/10 alkali used by fixed esters in 100 cc.
Per cent.	Per cent.	Cc.	Cc.	Cc.
1·2658	0·845	40·4	10·0	30·4
1·1348	0·820	47·6	8·8	38·8
1·0640	0·685	36·2	6·4	28·8
0·9726	0·596	32·2	7·2	25·0
0·7774	0·500	26·0	7·6	18·4
0·6840	0·392	26·6	4·8	20·9
0·6070	0·313	25·0	3·0	22·0
0·0306	—	18·8	12·4	6·4
0·0200	—	14·2	11·4	2·8
0·0054	Trace	9·6	9·6	0·0
0·0052	,,	16·4	15·4	1·0
0·0042	,,	10·0	7·4	2·6

TABLE IV.—*Determination of Fixed Esters in Pure Whiskies.*

Solids (per cent).	100 cc. of whisky.	Cc. N/10 alkali used by volatile esters in 100 cc.	Fixed esters in 100 cc.
0·3264	27·30	8·0	19·30
0·1976	21·20	9·50	11·70
0·1840	18·6	8·00	10·60
0·1690	15·8	5·2	10·60
0·1620	15·10	7·10	8·00
0·1592	13·4	5·8	7·60
0·1356	19·70	7·70	12·00
0·1164	7·70	2·00	5·70
0·0496	6·60	1·80	4·50

The question as to whether complete saponification could not be obtained in the cold by standing eighteen to twenty hours at room temperature with the excess of alkali was thoroughly tested in the following manner :—Duplicates were measured into flasks and the excess of alkali added, and stoppered, and allowed to stand over night. In the morning one was titrated and the other was heated for one hour with the tube condenser on the water-bath, cooled, and titrated. In thirty cases there was no difference between these titrations, and the average on 171 determinations was for the cold titrations 4·1 cc. N/10 alkali for 50 cc. of sample, and 4·2 cc. N/10 for 50 cc. of the sample that was heated, which indicates that practically complete saponification takes place at room temperature, and that the heating for one hour is not necessary, but in a few cases the titration of the cold saponified sample would be low, showing that complete saponification had not taken place. In our experience, therefore, it is safer

to complete the saponification by heating as directed in the method.

The samples that were heated on the water-bath always had a little more colour than the samples which were not heated, indicating a little more resinification of the aldehydes, which may account for the slightly higher results obtained by heating.

In order to check up the method of distillation the esters were determined in some artificial brandies before and after distillation. The results of four determinations on the original showed that 9 cc. of N/10 alkali were needed to saponify the esters in 100 cc., while, according to the average on twenty determinations on the distillate, 8·9 cc. were required for 100 cc., which shows that where the esters present are ethyl acetate, as they were in this sample, all are found in the distillate.

This experiment was repeated on five samples of new colourless whiskies with the same result, showing that the method of distillation is satisfactory, and that the esters are distilled over completely, although this does not prove that in the old aged whiskies there are not formed esters which are non-volatile, but it is impossible to distinguish them from colouring-matters and resinous materials which are affected by boiling with alkali, as has been shown.

(To be continued).

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 171).

Part II.—Analysis of the Silver, Copper, and Tin Groups.

General Discussion.

A survey of the main features of the method adopted for the analysis of the hydrochloric acid and hydrogen sulphide precipitates may be obtained by referring to the "Tabular Outline" accompanying this chapter. Here only the modifications introduced into the process ordinarily followed will be discussed.

In the precipitation and analysis of the silver group the usual process has been adhered to, the only addition being a provision for the detection of thallium, by removing the lead with sulphuric acid and then adding potassium iodide.

In the directions for the precipitation of the copper and tin groups by hydrogen sulphide, especial attention is given to securing the proper conditions as to acid concentration and temperature for a satisfactory separation of these elements from those of the iron group; for indefiniteness in this respect is one of the most common sources of difficulty to the inexperienced analyst. In our process, as will be seen by reference to P. 21, it is directly to precipitate first from a hot moderately acid solution. The fairly large acid concentration has the advantage of preventing the precipitation by hydrolysis of basic salts of titanium, bismuth, and antimonous antimony, and of hastening the precipitation of the arsenic. The high temperature promotes the precipitation of arsenic, molybdenum, and platinum, and causes all the sulphides to separate in a more readily filterable form. The solution is, however, finally diluted so as to contain 4 cc. of hydrochloric acid of specific gravity 1·12 in 100 cc., and is saturated with hydrogen sulphide in the cold; for only with an acid as dilute as this, and then in the cold, is it possible to precipitate as little as 1 or 2 mgrms. of cadmium or lead. Attention may be called to our experiments described in the chapter on "Confirmatory Experiments and References," which show that under these conditions the separation is a remarkably satisfactory one—at any rate from a qualitative analysis point of view, since not only is the precipitation of the copper and tin groups complete, but 1 mgrm. of zinc, iron, or nickel is found in the filtrate, even when 500 mgrms. of cadmium, copper, or tin are present.

In the case of substances originally dissolved without the use of nitric acid, which may therefore contain tin or antimony in the stannous or antimonous state, the hydrogen sulphide precipitate is, as usual, treated with ammonium polysulphide. The separation of certain elements by this reagent is, however, far from complete. Thus copper and mercury dissolve in not insignificant quantity in the polysulphide; and tin may remain entirely undissolved, even when several mgrms. are present, if cadmium, copper, or mercury is also present in large quantity; moreover, gold, platinum, and the elements allied to them divide themselves between the residue and solution to so large an extent and to so different an extent in different combinations, as to make this reagent entirely unsatisfactory for separating these elements; and with molybdenum the solution is seldom complete, though a large proportion of it always dissolves. New experiments confirmatory of these already known facts will be found described below in the chapter on "Confirmatory Experiments." Yet in a scheme devoted primarily to the common elements there seems to be no alternative process of separation which, on the whole, is nearly so satisfactory; especially since it is not difficult to separate tin from the elements of the copper group in the course of the analysis of the latter, and since enough copper and mercury always remain undissolved by the ammonium polysulphide to enable as little as 2 mgrms. to be detected.

In the case of substances not completely soluble in water, the treatment with nitric acid, recommended in Part I., converts tin and antimony into the higher state of oxidation; and this makes it practicable, as our experiments have shown, to substitute ammonium monosulphide for the polysulphide in the case of such substances, which constitute by far the larger proportion of those ordinarily submitted to analysis. This has the advantage of not dissolving cupric and mercuric sulphides appreciably, thereby not only making the tests for copper and mercury more delicate, but also making it possible to decide with certainty from the appearance of the precipitate produced by acid in the ammonium sulphide solution whether or not any element of the tin group is present. The monosulphide has, of course, the same defects as the polysulphide in not completely extracting tin and the rarer elements, but not in any more marked degree when these elements are in the higher state of oxidation. This will be evident by reference to the "Test Analyses of the Tin Group."

Tabular Outline.

Table IV.—*Analysis of the Silver Group.*

Precipitate.—$AgCl$, Hg_2Cl_2, $PbCl_2$, *$TlCl$. Treat with hot water (P. 12).

Solution.—$PbCl_2$, *$TlCl$. Add H_2SO_4 (P. 13).		*Residue.*—$AgCl$, Hg_2Cl_2. Pour NH_4OH through the filter (P. 15).	
Filtrate. *Tl_2SO_4. Add KI (*P. 13a).	*Precipitate.* $PbSO_4$. Dissolve in $NH_4C_2H_3O_2$, add K_2CrO_4 (P. 14).	Black residue, $HgNH_2Cl$ + Hg.	*Solution.* $Ag(NH_3)_2Cl$. Add HNO_3 (P. 15).
Yellow precipitate, *TlI.	Yellow precipitate, $PbCrO_4$.		White precipitate, $AgCl$.

* From the *Technology Quarterly*, xix., No. 3 September, 1906.

Tabular Outline (continued).

TABLE V.—*Analysis of the Copper Group.*

H_2S *Precipitate.*—HgS, PbS, Bi_2S_3, CuS, CdS, As_2S_3, As_2S_5 (with As_2S_3 and S_2), Sb_2S_3, Sb_2S_5, SnS, SnS_2, *PtS_2, *Au and *Au_2S_{1-3}, *Se, *Te (and TeS_2 ?), *MoS_{2-3}.
Digest with ammonium sulphide (P. 22).

Residue.—HgS, PbS, Bi_2S_3, CuS, CdS, [*PtS_2], [*Au and Au_2S_{1-3}], [*MoS_{2-3}]. Boil with HNO_3 (P. 23).

Residue.—HgS, SnO_2, *Au and *Au_2S_{1-3}, *PtS_2. Add Br_2 solution (P. 24).

Solution.—Pb, Bi, Cu, Cd, as nitrates. Add H_2SO_4, evaporate, add water (P. 26).

Residue.—SnO_2. Dissolve in $(NH_4)_2S$ (P. 25). Unite with tin group (P. 41).

Solution.—Add KCl, evaporate to a small volume (*P. 24*a*).

White precipitate, $PbSO_4$. Dissolve in ammonium acetate, add K_2CrO_4 (P. 14).

Filtrate.—Add NH_4OH (P. 27).

Yellow precipitate, $PbCrO_4$.

Yellow precipitate, *K_2PtCl_6.

Filtrate.—Add NaOH and $H_2C_2O_4$, and heat (*P. 24*a*).

Precipitate. $Bi(OH)_3$. Dissolve in HCl, evaporate, add to water (P. 28).

Filtrate.—$Cu(NH_3)_4SO_4$ (blue), $Cd(NH_3)_4SO_4$.

Purple precipitate, *Au.

Solution.—Add $SnCl_2$ (P. 24).

White precipitate, BiOCl. Add Na_2SnO_2.

To a small part add CH_3COOH and $K_4Fe(CN)_6$ (P. 29).

To the remainder add KCN and H_2S (P. 30).

White or grey precipitate, Hg_2Cl_2 or Hg.

Black residue, Bi.

Red precipitate, $Cu_2Fe(CN)_6$. White precipitate, $Cd_2Fe(CN)_6$.

Yellow precipitate, CdS.

Solution. $(NH_4)_3AsS_4$, $(NH_4)_3SbS_4$, $(NH_4)_2SnS_3$, *$(NH_4)_2PtS_3$ (?), *$(NH_4)_3AuS_3$ (?), *$(NH_4)_2SeS_3$ (?), *$(NH_4)_2TeS_3$ (?) *$(NH_4)_2MoS_4$. Add HCl (P. 41).

Precipitate.—See Table VI.

TABLE VI.—*Analysis of the Tin Group.*

Precipitate from Ammonium Sulphide Solution.—As_2S_5, Sb_2S_5, SnS_2, *PtS_2, *Au_2S_{3-6}, *SeS_2 (?), *TeS_2 (?), *MoS_3. Heat with 10 cc. HCl, 1·20 (P. 42).

Solution.—$SbCl_3$, $SnCl_4$. Dilute to 50 cc., heat, and pass in H_2S (P. 45).

Residue.—As_2S_5, *PtS_2, *Au, *Se, *Te, *MoS_3. Dissolve in HCl and $KClO_3$, evaporate to a small volume (P. 43).

Orange precipitate, Sb_2S_3. Dissolve in HCl, add Zn and Pt (P. 46).

Solution.—$SnCl_4$. Cool, dilute, pass in H_2S (P. 47).

Yellow precipitate, *K_2PtCl_6. Dissolve in hot water, add KI (*P. 43*a*).

Filtrate.—H_3AsO_4, *$AuCl_3$, *H_2SeO_3, *H_2TeO_3, *H_2MoO_4. Add NH_4OH, NH_4Cl, and $MgCl_2$ (P. 44).

Black deposit, Sb. Treat with NaOCl.

Yellow precipitate, SnS_2. Dissolve in HCl, add Zn (P. 47).

Dark red colour, *K_2PtI_6.

White precipitate, $MgNH_4AsO_4$. Dissolve in HCl, add H_2S (P. 44).

Filtrate.—Heat with $H_2C_2O_4$, filter (*P. 43*b*).

Black deposit, Sb.

Grey deposit, Sn. Dissolve in HCl, add $HgCl_2$ (P. 47).

Yellow precipitate, As_2S_5, As_2S_3, and S.

Purple or dark yellow precipitate, *Au.

Filtrate.—Evaporate, add strong HCl and Na_2SO_3 (*P. 43*c*).

White precipitate, Hg_2Cl_2.

Red precipitate, *Se.

Filtrate.—Add water and KI (*P. 43*d*).

Black precipitate, *Te.

Filtrate.—Boil off SO_2, add KCNS and Zn (*P. 43*e*).

Deep red colour, *$Mo(CNS)_4$.

In the process of analysis of the copper group (see Table V.) the only important modification introduced has reference to the extraction of the tin, which may, as just stated, remain wholly in the residue undissolved by ammonium sulphide. The residue undissolved by nitric acid, which may consist of mercuric sulphide and metastannic acid, is treated with bromine water instead of with an acid oxidising mixture, in order to dissolve out the mercury and leave behind the tin, which can then be dissolved in ammonium sulphide and united with the main solution of the tin group.

For the analysis of the tin group various processes have been proposed, and are in general use. As will be seen from Table VI., the method of separation here adopted is based entirely on the different solubilities of the three sulphides of arsenic, antimony, and tin in hydrochloric acid of varying concentration. This process, which seems to have been first suggested for the separation of antimony and tin by Loviton (*Journ. Chem. Soc.*, 1888, liv., 992), and which has been utilised in part by Bailey and Cady in their text-book on qualitative analysis, we have somewhat developed by a detailed study of the best conditions for making it a good qualitative method. We believe this method is the one best adapted to the purposes of ordinary qualitative analysis, because of its great simplicity, and because of the fact that the tests, while being of sufficient delicacy to detect 1 mgrm. of any of these elements, do not have in the case of arsenic and antimony the extreme sensitiveness of the reduction tests based on the decomposition by heat of hydrogen arsenide and antimonide.

Of the rarer elements precipitable by hydrogen sulphide, provision has been incidentally made for the detection of all the more important ones, namely, for that of molybdenum, selenium, tellurium, gold, and platinum. The treatment with hot concentrated hydrochloric acid employed for separating the sulphides of antimony and tin from that of arsenic makes such provision comparatively simple; for the sulphides of all these rarer elements are left, with that of arsenic, together at one place in the scheme (except that gold and platinum may also remain in the copper group residue, and have to be tested for also in the analysis of that group). No attempt has been made to include the other so-called platinum elements, since the reliable detection of these can be effected only by a special and complicated process. These elements will be treated in the "System of Analysis including nearly all the Metallic Elements," which is being published in the *Technology Quarterly*.

(To be continued).

SEPARATION AND ESTIMATION OF BERYLLIUM.

By CHARLES L. PARSONS and S. K. BARNES.

THE separation of beryllium from other elements presents little difficulty except in the case of aluminium and iron. It will invariably be found with aluminium in the last instance, and the problem therefore becomes the determination of beryllium in such a mixture.

Many methods for the separation of beryllium from iron and aluminium have been proposed, but the one most often used has been founded upon the solubility of its hydroxide in ammonium carbonate, which unfortunately dissolves also some of the hydroxides of aluminium and iron. Vauquelin (*a*) in 1798 first used ammonium carbonate, but his first separation depended upon the solubility of beryllium hydroxide in potassium hydroxide and its precipitation on boiling. Gmelin (*b*) and Schaffgotsch (*c*) both used this same method, but it is very far from being accurate. Sheerer (*d*) first proposed the separation of the last traces of iron from the ammonium carbonate solution by means of ammonium sulphide. Berthier (*e*) suggested the use of ammonium sulphite as a reagent, but the method was shown to be valueless by Böttinger (*f*). In 1850 Rivot (*g*) proposed the ignition of the oxides in a current of hydrogen whereby the iron was reduced to metal and could be dissolved out with dilute nitric acid or its mass determined by the loss of weight. Debray (*h*) developed a separation dependent upon the action of zinc on the mixed sulphates precipitating the aluminium as a basic sulphate, but the method was never made quantitative. Joy (*i*) made a comparative study of all methods proposed to his time. Gibbs (*k*), in 1864 for the first time, suggests the use of sodium fluoride to quantitatively separate aluminium from beryllium, and Pollok (*l*) shows that the fluoride separation is exceedingly sharp. Cooke (*m*), after reducing the iron in hydrogen, volatilises it in a current of hydrochloric acid. Havens and Way (*n*) accomplish the same result without previous reduction of the oxide. Rössler (*o*) succeeded in separating beryllium from small amounts of aluminium by precipitating with ammonium phosphate in the presence of citric acid. Vincent (*p*) uses dimethylamine to precipitate beryllium salts, and finds that the aluminium compound is soluble in excess of the reagent. Iron acts like beryllium. Renz (*q*) confirms this, states the same to be true of methyl-, ethyl-, and diethylamine, and claims the results to be quantitatively accurate. Zimmermann (*r*) in 1887 returns to the old potassium hydroxide and sulphite or thiosulphate method without any special addition. Scheier (*s*) in 1892, Atkinson and Smith (*t*) in 1895, and Burgass (*u*) in 1896 separated iron quantitatively from beryllium by means of nitroso-β-naphthol. Lebeau (*x*) precipitates the iron in nitric acid solution by ferrocyanide, removes the ferrocyanide by copper nitrate, and the excess of copper by hydrogen sulphide. Hart (*y*) removes the major part of both iron and aluminium by careful precipitation of the sulphates with sodium carbonate, the beryllium being the last to precipitate, owing to the great solubility of its own hydroxide in its own sulphate. Havens (*z*) separates beryllium from aluminium quantitatively by the insolubility of hydrous aluminium chloride in a mixture of hydrochloric acid and ether which has been saturated with hydrochloric acid gas. Haber and Van Oordt (*aa*) dissolve basic beryllium acetate in chloroform, leaving aluminium and iron acetates behind. Myers (*bb*) removes iron electrolytically from a slightly acid solution of the sulphates, using a mercury cathode. Parsons and Robinson (*cc*) separate beryllium basic acetate in a pure state from other acetates by means of its ready solubility in hot glacial acetic acid and comparative insolubility in the same reagent when cold.

Preliminary Investigations.

Some qualitative work done by one of us some months ago had developed the fact that beryllium hydroxide was readily, immediately, and apparently completely separated from aluminium and ferric hydroxides by boiling momentarily in a saturated solution of acid sodium carbonate. No trace of aluminium could be found in the separated beryllium compound by Havens's method (*dd*), and the white hydroxide of beryllium or its hydrochloric acid solution showed scarcely a trace of colour. The object of this investigation was to determine whether or not this reaction could be made strictly quantitative.

Solutions of pure aluminium chloride and pure beryllium chloride were made and analysed, and it was early apparent on attempting to get closely agreeing results by precipitating the beryllium as hydroxide with ammonia that some source of error existed. After some experimenting it was found that the beryllium hydroxide, when freed of the ammonium chloride present, passed into the colloidal condition on washing with pure water, and, indeed, much more rapidly than is known to be the case with aluminium. On adding a small amount of ammonium acetate to the wash-water the difficulty immediately disappeared, and no trouble was experienced in obtaining well-agreeing results even in fairly strongly ammoniacal solution. Small amounts of beryllium hydroxide also adhere tenaciously to the glass of the precipitating beaker,

and after as perfect mechanical removal as possible the beaker should be treated with a little dilute nitric acid, and the contained beryllium re-precipitated. Beryllium oxide obtained by blasting the hydroxide is somewhat hygroscopic, and should be weighed with due precautions.

References.

(*a*) Vauquelin, *Ann Chim. Phys.*, xxvi., 155.
(*b*) Gmelin, *Ann. Physik.*, l., 175.
(*c*) Schaffgotsch, *Ibid.*, l., 183.
(*d*) Scheerer, *Ibid.*, lvi., 479.
(*e*) Berthier, *Ann. Chim. Phys.*, [3], vii., 74.
(*f*) Böttinger, *Ann.*, li., 397.
(*g*) Rivot, *Ann. Chim. Phys.*, [3], xxx., 188.
(*h*) Debray, *Ibid.*, [3], xliv., 1.
(*i*) Joy, *Am. Journ. Sci.*, [2], xxxvi., 83.
(*k*) Gibbs, *Ibid.*, [2], xxxvii., 346.
(*l*) Pollok, *Trans. Roy. Dublin Soc.*, 1904, [2], 139..
(*m*) Cooke, *Am. Journ. Sci.*, [2], xlii., 78.
(*n*) Havens and Way, *Ibid.*, [4], viii., 217.
(*o*) Rössler, *Zeit. Anal. Chem.*, xvii., 148.
(*p*) Vincent, *Bull. Soc. Chim.*, xxxiii., 157.
(*q*) Renz, *Ber.*, xxxvi., 2751.
(*r*) Zimmermann, *Zeit. Anorg. Chem.*, xv., 285.
(*s*) Scheier, *Chem. Zeitung*, xvi., 420.
(*t*) Atkinson and Smith, *Journ. Am. Chem Soc.*, xvii., 688.
(*u*) Burgass, *Zeit. Angew. Chem.*, 1896, 596.
(*x*) Lebeau, *Comptes Rendus*, cxxi., 641.
(*y*) Hart, *Journ. Am. Chem. Soc.*, xvii., 604.
(*z*) Havens, *Am. Journ. Sci.*, [4], iv., 111.
(*aa*) Haber and Van Oordt, *Zeit. Anorg. Chem.*, xl., 465.
(*bb*) Myers, *Journ. Am. Chem. Soc.*, xxvi., 1124.
(*cc*) Parsons and Robinson, *Ibid.*, xxviii., 555.
(*dd*) Havens, *loc. cit.*

Separation and Determination.

The method is based on the total insolubility of aluminium and ferric hydroxide in a 10 per cent boiling acid sodium carbonate solution, and on the total solubility of beryllium hydroxide in the same. From the aluminium solution used the aluminium hydroxide was totally precipitated by the boiling hot saturated solution of acid sodium carbonate and the beryllium solution gave a perfectly clear solution with the same. The acid sodium carbonate employed was in the form of small crystals, and contained but a trace of the normal carbonate as indicated by phenolphthalein.

Portions of the solutions of beryllium and aluminium chlorides were weighed out containing amounts convenient to work with, and washed from the weighing-bottle into clean Jena beakers of 250 cc. capacity in which the separation was made.

The solution was made up to about 100 cc., neutralised as nearly as possible with ammonia, and 10 grms. of solid acid sodium carbonate added. If the solid carbonate is added to any but a cold solution spattering will take place.

The beakers were kept covered with watch-glasses to prevent loss of material by any escaping gas during the heating, and the solution was brought to a boil as quickly as possible, and allowed to boil not to exceed one minute. Carbon dioxide is not evolved very rapidly till the boiling temperatare is nearly reached if the solutions are neutral, but evolution of gas must not be mistaken for boiling.

The solution was now set in cold water, and cooled, filtered, and washed two or three times with hot water. The precipitate was dissolved on the filter with as little as possible (1 : 1) hydrochloric acid, and run back into the same beaker in which the precipitation was first made, the solution made up to 100 cc., made neutral with ammonia, precipitated again with acid sodium carbonate as before, cooled, filtered, and washed with hot water, running both filtrates together. A cloudiness will be noticed in the combined filtrates after washing, which looks as if aluminium hydroxide were coming through, but this is not the case, the cloudiness being due to the dilution of the strong acid sodium carbonate solution with water. The aluminium hydroxide was again dissolved in (1 : 1) hydrochloric acid, precipitated with ammonia and determined in the ordinary way, as it was found that it was next to impossible to wash out all the acid sodium carbonate from the gelatinous precipitate.

The filtrate from the double precipitation, containing the beryllium in solution, was carefully acidified with strong hydrochloric acid in a covered beaker, as special care was required that the escaping gas should not cause mechanical loss. Just before neutralisation a portion of the beryllium was thrown down as hydroxide, but this immediately dissolved on addition of more acid. The solution was then boiled to remove carbon dioxide so that no ammonium carbonate should be formed, precipitated with ammonia, boiled, allowed to settle, and filtered, washing with ammonium acetate solution until free from chlorides. The beryllium hydroxide was ignited to constant weight, which is readily attained, and weighed.

Results follow :—

Al_2O_3 taken.	Al_2O_3 found.	BeO taken.	BeO found.	Total taken.	Total found.
0·1252	0·1266	0·0818	0·0810	0·2070	0·2076
0·1323	0·1336	0·0795	0·0781	0·2118	0·2117
0·0942	0·0957	0·0573	0·0563	0·1515	0·1520
0·0869	0·0881	0·0610	0·0588	0·1479	0·1469
0·0907	0·0945	0·0629	0·0594	0·1536	0·1539

The results are slightly too high in aluminium oxide and correspondingly low in beryllium oxide, although the totals found agree closely with the theoretical amounts. The aluminium hydroxide showed therefore, as was to be expected, a tendency to occlude some beryllium hydroxide. Washing the first and second precipitation with hot acid sodium carbonate solution was next tried, and this seemed to assist in removing the beryllium, although small amounts were still left behind in the aluminium hydroxide, as the following results will show :—

Al_2O_3 taken.	Al_2O_3 found.	BeO taken.	BeO found.	Total taken.	Total found.
0·0840	0·0849	0·0646	0·0642	0·1486	0·1491
0·0740	0·0749	0·0680	0·0676	0·1420	0·1425
0·2059	0·2055	0·0972	0·0977	0·3031	0·3032
0·6152	0·6167	0·0372	0·0348	0·6524	0·6515
0·1327	0·1346	0·3125	0·3107	0·4452	0·4453
0·1368	0·1386	0·3050	0·3031	0·4418	0·4417
0·6233	0·6250	0·0730	0·0714	0·6963	0·6964

Trials were made of heating the acid sodium carbonate solution in pressure flasks so that no carbon dioxide might escape, but the results were not satisfactory.

By the procedure so far followed the mixed hydroxides were first precipitated together in the cold, and the beryllium hydroxide dissolved in the boiling reagent. This would seemingly tend to allow the aluminium hydroxide to so enclose some of the solid beryllium hydroxide that the reagent could not act upon it. This was particularly the case when relatively large amounts of aluminium were present. To overcome this difficulty as much as possible, separations were tried by adding the boiling hot mixture of the chlorides to a nearly boiling solution of acid sodium carbonate containing enough of the reagent to make the mixed liquid an approximately 10 per cent solution. The whole was then brought to a boil, held there for half a minute, cooled, and treated as before. By this procedure only the aluminium was precipitated as hydroxide, and less beryllium was mechanically retained. Larger amounts of aluminium were used in this case than before, and as the results could be interpreted from the beryllium alone the aluminium was not weighed.

BeO taken.	BeO found.
0·1311	0·1307
0·1424	0·1415
0·2522	0·2515
0·0671	0·0664
0·0642	0·0631

To show the application of this same procedure in the presence of iron, ferric chloride was added in variable amounts, both large and small, to mixtures of aluminium and beryllium chlorides, boiled with a little nitric acid to ensure oxidation, and the whole treated as above. The combined hydroxides of iron and aluminium were several times the mass of the beryllium hydroxide, yet the separation was almost complete, and the resulting beryllium oxide was analytically pure.

BeO taken.	BeO found.
0·2152	0·2146
0·0911	0·0906
0·0825	0·0806
0·1020	0·0995

Considering the well known great tendency of gelatinous hydroxides like those of aluminium and iron to retain other substances which may be present, this separation of beryllium leaves little to be desired. Care must, of course, be exercised to bring the acid sodium carbonate quickly to a boil, and to boil for a moment only, for if too much carbon dioxide is lost the aluminium may partially pass into solution.

Conclusions.

Beryllium hydroxide must be washed with water containing an electrolyte to prevent the loss of colloidal hydrate through the filter.

Beryllium can be quantitatively separated from iron and aluminium by means of the solubility of its hydroxide in a boiling hot solution of acid sodium carbonate of approximately 10 per cent strength.—*Journal of the American Chemical Society*, xxviii., No. 11.

PROCEEDINGS OF SOCIETIES.

SOCIETY OF CHEMICAL INDUSTRY.

(LONDON SECTION).

Ordinary Meeting, April 8th, 1907.

Mr. R. J. FRISWELL in the Chair.

"*Observations on Cotton and Nitrated Cotton.*" By HENRY DE MOSENTHAL, F.I.C.

This paper is a continuation of one of the same title read on March 31st, 1904, before the London Section. It deals with the appearance of celluloses and nitro-celluloses in polarised light, their refractive indices and optical activity as well as densities. Fourteen samples of nitrated cottons of different degrees of nitration, different solubility and viscosity, three samples of nitrated wood cellulose, and two each of nitrated ramie and flax were examined. The appearance in polarised light was found to vary with the degree of magnification and the light used, fibres appearing differently when dry and when moistened. Various moistening liquids gave different results. The colours shown in polarised light under the same conditions seemed to be chiefly dependent on the material nitrated and the method of nitration. The densities of celluloses and of nitro-celluloses examined were found to be higher than those recorded in text-books. The densities of nitrated material in solution were also ascertained, and found to be higher than in the solid state. Observations of the refractive index of nitrated cotton in solution gave results which were not concordant, and therefore determinations were made on transparent films of nitrated cotton, ramie, and flax. The refractive index of cellulose was found by examining denitrated films, and then by placing fibres in a liquid of like refraction. Atomic refractions were applied to some of the proposed formulæ for cellulose, and showed that the cellulose molecule has no double bonds. Although for the present without stoichiometrical value, the dispersion was determined and the reciprocal of the relative dispersion calculated. The optical activity of various nitro-celluloses in solution was found to agree fairly well with the figures given by Vignon. The range of concentration within which clear solutions could be obtained made it impossible to establish constants. The paper concludes with a reference to work in progress with regard to the dialysis of nitro-cellulose and solution pressures generally.

NOTICES OF BOOKS.

Qualitative Analysis. By WILLIAM CONGER MORGAN, Ph.D. (Yale). New York: The Macmillan Company. London: Macmillan and Co., Ltd. 1906.

THIS book has the excellent object of imparting principles rather than facts to the student, and giving him a due idea of the relative importance of the facts he has assimilated in his elementary work, an idea which the majority of beginners lack to a very marked degree. The treatment is based upon the ionic theory of dissociation, and in the first or general part some fundamental principles are discussed, such as mass action, hydrolysis, oxidation, and reduction; some processes which are commonly employed in qualitative analysis are explained, and the theory of ionisation is gone into fairly fully. In the second part the classification of the elements according to the Periodic System is discussed, and the characteristic properties of the commoner members of the groups are described. In this part the knowledge the student will have acquired from his reading is worked in very well with his analytical work, which will thus be established upon a thoroughly sound basis. Systematic analysis is treated in the third part in a fairly advanced and very thorough manner, and the book will commend itself for those who want a work of reference perhaps more than a laboratory text-book, for which it is rather too discursive. However, the reason for every step taken is carefully explained, while excellent notes are given on the detection of interfering substances.

Handbook of Metallurgy. By Dr. CARL SCHNABEL. Translated by HENRY LOUIS, M.A. Second Edition. Vol. II. London: Macmillan and Co., Ltd. New York: The Macmillan Company. 1907.

THE second volume of the translation into English of Dr. Schnabel's valuable and comprehensive work on metallurgy deals with the metals zinc, cadmium, mercury, bismuth, tin, antimony, arsenic, nickel, cobalt, platinum, and aluminium, and describes fully the methods of extracting them from their ores, including those processes which are as yet of merely scientific interest as well as those practically employed. The physical and chemical properties of the metals are discussed, and also the composition of their alloys, and a short *résumé* is in each case given of the reactions of the metal and their most important compounds.

The Chemistry of Gas Manufacture. By W. J. ATKINSON BUTTERFIELD, M.A., F.I.C. Fourth Edition. Volume I. London: Charles Griffin and Company, Ltd. 1907.

THE revision of the second edition of this handbook entailed the addition of so much new matter that the author has thought it advisable to issue it in two volumes. The first of these deals with the materials and processes of gas manufacture, and already two editions of it have appeared, while Volume II. is to published shortly. The first volume describes the properties and composition of peat, coal, oils, &c., while a short account is given of the analysis of coal. In this the author appears to have committed an error of judgment in assuming that the student would require no instruction in the method of carrying out combustions, which can hardly be regarded as very

elementary work, while on the other hand he takes the trouble to explain in detail the very simple process of finding the specific gravity of a solid, which the modern schoolboy surely has at his fingers' ends. The plant necessary for the manufacture of coal-gas is described with explanatory diagrams and illustrations, and methods of gas purification according to the scheme which is generally adopted in London is given full consideration. The manufacture of carburetted water-gas and oil-gas is discussed, and schemes for the enrichment of gas form the subject of the last chapter, which also goes shortly into questions connected with its storage and distribution, the author thinking it unnecessary to treat them in full, as properly speaking they belong to the province of the engineer.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 12, March 25, 1907.

This number contains no chemical matter.

No. 13, April 2, 1907.

Properties of a Body extracted from certain Alloys of Nickel and Tin.—Em. Vigouroux.—The alloys described in a previous article were submitted alternately to the action of hot nitric acid and fused caustic potash, with a final washing with dilute nitric acid. The compound NiSn (33·24 Ni, 66·76 Sn) was thus isolated. This body is generally obtained in the form of a silvery white crystalline powder, showing brilliant facets under the microscope. Its density (in melting ice) is about 8·44, the calculated number being 7·93; its formation is therefore accompanied by contraction. At red heat it is attacked by both chlorine and oxygen, to give chlorides and oxides of the two metals; the sulphides are also equally easily obtained. Hydrochloric acid, sulphuric acid, and aqua regia dissolve it completely. Nitric acid produces scarcely any effect, and the fused alkalis react very slowly. *Conclusions.*—1. Certain bronzes, with nickel substituted for copper, containing from 73·64 to 91·72 per cent tin, treated alternately with nitric acid and caustic potash, gradually lose in tin until a certain limit is reached, which is the same for all, of about 66·74 per cent, and corresponding to the formula NiSn. 2. This non-magnetic body, presenting the characteristics of a definite compound, is apparently the only substance which can be isolated from this class of alloys; in other words, the richest nickel-tin compounds would contain the metals combined in the proportions of 1 to 2.

Berichte der Deutschen Chemischen Gesellschaft. Vol. xl., No. 4, 1907.

Salts of Zirconium.—Arthur Rosenheim and Paul Frank.—The authors' earlier work has shown that, generally speaking, no compound of a tetravalent Zr····ion can exist in aqueous solutions even if they are strongly acid, but usually only zirconyl salts of the divalent ZrO··-ion. Ruer has shown that zirconium sulphate, $Zr(SO_4)_2.4H_2O$, is not the normal sulphate of zirconium, but behaves like a complex zirconyl sulphuric acid, $ZrO(SO_4H)_2.3H_2O$. A normal nitrate, $Zr(NO_3)_4.5H_2O$, has been obtained by Paykull from solutions made strongly acid with nitric acid. The authors have continued these investigations with the following results:—The substances which separate from solutions containing large quantities of mineral acids were first studied, except the phosphates which form insoluble amorphous precipitates, and the above statements were confirmed. From solutions containing hydrobromic and hydrochloric acids the compounds $ZrOBr_2.8H_2O$ and $ZrOCl_2.8H_2O$ separate. From hot concentrated nitric acid solution the zirconyl salt, $ZrO(NO_3)_2.2H_2O$, crystallises, but if a solution of freshly precipitated zirconium hydroxide in nitric acid prepared at the ordinary temperature is evaporated at 15° *in vacuo* over phosphorus pentoxide and caustic soda large prisms appear. These are very hygroscopic, and give up nitric acid in dry air. They consist of Paykull's normal nitrate, $Zr(NO_3)_4.5H_2O$. Ruer's work with the sulphate was completely confirmed. Zirconyl salts in neutral aqueous solution are fairly rapidly hydrolysed, giving colloid zirconium hydroxide. Zirconyl nitrate when finely powdered dissolves after long boiling in absolute alcohol, and from this solution a white powder is precipitated by ether, $Zr_2O_3(NO_3)_2.5H_2O$. From aqueous solutions of the sulphate, by the addition of potassium rubidium or cæsium sulphate, crystalline precipitates of the composition $R_2Zr_2O_3(SO_4)_2$ can be obtained. These readily hydrolyse in pure water, and must therefore be re-crystallised from dilute alkali sulphate solution. No stable double salts can be prepared from zirconium nitrate. If oxalic acid is added to an aqueous solution of a zirconyl salt (chloride or nitrate) a gelatinous precipitate results soluble in excess of oxalic acid. If dilute sodium acetate solution is added the precipitate can be filtered, dried, and analysed. Its formula is $ZrO(C_2O_4).4H_2O$. When aqueous oxalic acid solution is added to zirconium hydroxide and boiled, an acid oxalate, $Zr(OH)(C_2O_4H)_3.7H_2O$, separates. The cautious addition of tartaric acid solution to a solution of zirconium oxychloride gives a precipitate of the composition shown by the formula $Zr_3(OH)_8(C_4H_2O_6).6H_2O$.

Zirconium Tetrachloride and Colloid Zirconium Hydroxide.—Arthur Rosenheim and Julian Hertzmann.—When an ethereal solution of benzoic acid ethyl ester is heated with zirconium tetrachloride, crystals having the formula $ZrCl_4(C_6H_5.CO_2C_2H_5)_2$ separate. Ketones and aldehydes also react with the tetrachloride, also salicylic acid and aldehyde, formic acid, acetic acid, &c. The compound with acetic acid consists of microscopic prisms easily soluble in water and alcohol, but insoluble in ether. It gives up acetic acid in the air, yielding zirconyl acetate, $ZrO(CH_3CO_2)_2$, which in moist air gives up more acetic acid, undergoing hydrolysis. Hydrolysis also occurs in aqueous solution, and colloid zirconium hydroxide is formed. After dialysing a 1½ per cent solution of zirconium acetate for about a week an absolutely clear solution is obtained; it coagulates on heating on a water-bath, and contains all its zirconium hydroxide in the colloid form; on addition of dilute potassium chloride solution and boiling, the zirconium chloride is precipitated quantitatively.

Reductions with Amorphous Phosphorus (II.).—Th. Weyl.—The action of amorphous phosphorus upon nitrobenzene in presence of alkali was investigated—(1) by means of experiments carried out at the ordinary pressure with a reflux condenser; (2) experiments at the ordinary pressure in which the reacting mixture was heated on an oil-bath with a reflux condenser; and (3) experiments in closed tubes at increased pressure. It was found that when nitrobenzene is allowed to drop into a boiling mixture of caustic soda, water, and red phosphorus, and the liquid is distilled in a current of steam, aniline and nitrobenzene are found in the distillate, and the nascent phosphine has undoubtedly acted as a reducing agent. If nitrobenzene is boiled for some time with the mixture generating phosphine—it is immaterial whether the pressure is raised or not—besides aniline the whole series of intermediate products between nitrobenzene and aniline is formed, viz., azoxybenzene, hydrazobenzene, and azobenzene. Large quantities of soluble substances, *e.g.*, phenols, are also formed. Thus the action of alkali and phosphorus upon nitrobenzene is essentially different from the action of water and phosphorus. The latter gives aniline, and under suitable conditions more than 80 per

cent of the theoretical yield; the former, on the other hand, acts as a feeble reducing agent, producing the intermediate products between nitrobenzene and aniline. The equations are:—

I. $2C_6H_5NO_2 + PH_3 = C_6H_5.N{<}_{O}{>}N.C_6H_5 + H_3PO_3$.

II. $3C_6H_5.N{<}_{O}{>}N.C_6H_5 + PH_3 = C_6H_5.N{:}N.C_6H_5 + H_3PO_3$.

III. $3C_6H_5NO_2 + 4PH_3 = 3C_6H_5NH_2 + 2H_3PO_3 + 2P$.

Salts of Copper Tetrasulphide Hydrogen Acid.—Heinrich Biltz and Paul Herms.—The best known of the double polysulphides of copper is ammonium copper tetrasulphide, $NH_4[CuS_4]$. It may be prepared by diluting ammonia solution with water and saturating with sulphuretted hydrogen. One half of the acid sulphide solution is then saturated with sulphur at 40°, filtered, and added to the other half, and an aqueous solution of copper sulphate is then added. A black precipitate results, and may be filtered off, while the filtrate yields red crystals of $NH_4[CuS_4]$ if it is allowed to stand over-night. To prepare from it the potassium salt a solution of it in sodium hydroxide solution is made, and alcoholic potash added. The brown-red turbidity is removed, and the dark red crystalline $K[CuS_4]$ is deposited from the filtrate. The rubidium and cæsium compounds may be prepared similarly. All the compounds of the formula $Me[CuS_4]$ crystallise in small prisms; they are only slightly soluble in alcohol and cold water, their solubility increasing rapidly with the increase of the atomic weight of the alkali metal. They are decomposed only slowly by concentrated mineral acids in the cold, but more quickly by dilute acids, especially when heated. They decompose slowly in the air at the temperature of the room, decomposition being favoured by the presence of moisture. The action of cupric oxide on potassium pentasulphide solution also produces $K[CuS_4]$. When cuprous oxide or cuprous sulphide acts upon potassium pentasulphide solution a new salt is obtained which is very similar to the tetrasulphide, but differs from it in colour and in composition. Its empirical formula is $K_3Cu_2O_2S_9$. All these alkali copper sulphide salts are red. When they were prepared from ammonium copper tetrasulphide the formation of black compounds was observed, especially when only a little alcohol was used. The crystals thus obtained appeared to have the empirical formula $K_2Cu_3S_{10}$.

MISCELLANEOUS.

The London Geological Field Class has arranged its Excursions for the study of the London district, under the direction of Professor Seeley, to commence on Saturday, April 27th. Mr. J. W. Jarvis, St. Mark's College, Chelsea, is the Honorary Secretary.

Royal Institution.—On Tuesday next, April 23rd, at 3 o'clock, Professor William Stirling will deliver the first of a course of three lectures at the Royal Institution on "Stimulation, Luminous and Chemical"; and on Thursday, April 25th, at the same hour, Dr. A. W. Verrall delivers a lecture on "Euripides and His Age," and on May 2nd on "The Bacchants of Euripides." The Friday Evening Discourse on April 26th will be delivered by Mr. J. Swinburne on "New Illuminants," and on May 3rd by Sir James Crichton-Browne on "Dexterity and the Bend Sinister."

Awards, Milan Exhibition, 1906.—The following awards have been conferred on the Wellcome Chemical Research Laboratories by the International Jury of the Milan Exhibition, 1906:—Chemical Arts and Pharmacy: Exhibit illustrating researches conducted in the Wellcome Chemical Research Laboratories, Grand Prix. *Collaborators' Awards.*—Chemical Arts and Pharmacy: Dr. F. B. Power (Director), Gold Medal; Mr. F. Tutin, Gold Medal; Mr. P. E. F. Perrédès, Silver Medal. Section of Education: Dr. F. B. Power (Director) Diploma of Honour.

Decomposition of Antimony Hydride.—Alfred Stock, Franz Gomolka, and Hans Heynemann.—The authors have carried out an extensive series of experiments which show that in pure glass vessels antimony hydride decomposes at first very slowly at room temperature. In proportion as more antimony separates—in the form of fairly large well-shaped crystals—the velocity of the decomposition increases. If the walls of the vessel are heated to 150° they are covered all over in a few minutes with an antimony mirror. If the vessel is heated to 200° the hydride decomposes with an explosion. In vessels in which the interior is artificially made rough or is covered with silver or arsenic the decomposition begins at once fairly quickly, and its rate rapidly increases up to a certain velocity. The influence of the layer of antimony on the decomposition of antimony hydride was thoroughly investigated with the help of the microscope. Mirrors of metallic antimony which are produced by warming the hydride, mirrors of black antimony resulting from the sublimation of antimony in a vacuum and condensation of the vapour at the temperature of liquid air, and those of sublimed metallic antimony, all have different activities. The activity of the mirror is dependent not only upon the extent but also upon the form of the surface of the metal. As soon as the different mirrors reach a certain thickness by the decomposition of larger quantities of antimony hydride their activity becomes the same. It also remains practically constant on further decomposition of the hydride. When hydrogen is mixed with the hydride the velocity of the reaction is not altered. Hence the decomposition of antimony hydride is not influenced by the hydrogen formed during the reaction. The temperature coefficient of the velocity of the reaction is 2·050 for 15—25°, 1·909 for 25—39°. Antimony mirrors deposited by the hydride are "poisoned" by oxygen. Such "poisoned" mirrors in contact with the hydride remain inactive for some time, and then recover very quickly. The poisoning cannot be ascribed to the oxidation of black antimony formed as an intermediate product. Mirrors of black antimony are not affected by oxygen. With an antimony mirror of constant activity the relative velocity of decomposition increases with decreasing concentration of the hydride. At 25° it is approximately inversely proportional to the square root of the hydride concentration.—*Berichte*, xl., No. 2.

Halogen Salts of Ruthenium.—A. Gutbier and H. Zwicker.—The authors have found that the double salts of ruthenium haloids with the halogen hydrates of organic bases of the composition $RuX_4.2RNH_2.HX$ or $RuX_6.(RNH_3)_2$ (hexa halogen ruthenates) can be prepared in a state of great purity, while the halogen ous-salts derived from the ruthenic haloids, RuX_3, have a peculiar composition, and were therefore further investigated. The derivatives of the ruthenium haloids can be prepared in two ways:—(*a*) The ruthenic haloid solution is saturated with the halogen and mixed with a solution of the halogen hydrate at the base; or (*b*) the ruthenic haloid solution is mixed with the solution of the halogen hydrate, any precipitate formed is dissolved in dilute halogen acid, and chlorine or bromine gas is led over the clear cooled liquid. In both cases the ruthenous haloid salts soon separate as coloured, crystalline, very stable precipitates, which dissolve in water with difficulty, undergoing more or less decomposition. They can be re-crystallised from the corresponding halogen acid, containing more or less free chlorine or bromine. The chlorous salts are green, and dissolve in hydrochloric acid with a red coloration. The bromous salts are blue-black, and give a blue coloration with hydrobromic acid.—*Berichte*, xl., No. 3.

MEETINGS FOR THE WEEK.

MONDAY, 22nd.—Society of Arts, 8. (Cantor Lectures). "Detergents and Bleaching Agents used in Laundry Work," by Prof. Herbert Jackson, F.I.C., &c.

TUESDAY, 23rd.—Royal Institution 3. "Stimulation, Luminous and Chemical," by Prof. William Stirling, M.D., &c.

—— Society of Arts, 4.30. "Social and Economic Conditions in Australia," by the Hon. John Winthrop Hackett, LL.D.

WEDNESDAY, 24th.—Society of Arts, 8. "Rubber Cultivation in the British Empire," by Herbert Wright.

THURSDAY, 25th.—Royal Institution, 3. "Euripides and His Age," by A. W. Verrall, Litt.D.

FRIDAY, 26th.—Royal Institution, 9. "New Illuminants," by James Swinburne, F.R.S.

—— Physical, 5. "Electrical Conduction produced by Heating Salts," by A. E. Garrett. "Influence of Pressure upon Convection Currents, and a Criticism of J. Stark's Relation between Cathode Fall of Potential and Temperature," by W. S. Tucker. "Solenoids which are Turned by the Earth's Magnetic Field," by W. B. Croft. "Simple Apparatus for Mechanically Illustrating the Tangent and Sine Laws," by J. A. Tomkins.

SATURDAY, 27th.—Royal Institution, 3. (The Tyndall Lectures). "Studies in Magnetism," by Prof. Silvanus P. Thompson, F.R.S.

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ANALYST'S DEPARTMENT.

Wanted, an ASSISTANT to the COUNTY ANALYST. Experience in analysis of Food and Drugs essential. Preference given to applicants possessing Institute of Chemistry qualification. Salary £120, increasing annually by £10 to maximum of £150. Forms of application, and particulars of duties and terms of engagement, may be obtained at my office, and will be forwarded on receipt of a stamped addressed foolscap envelope.

Applications (endorsed "Analytical") must be upon the form provided, and must reach me not later than 10 a.m. on TUESDAY, the 7th day of MAY next.

Canvassing in any form will be a disqualification.

Dated this 17th day of April, 1907.

N. J. HUGHES-HALLETT,
Clerk of the Derbyshire County Council.

County Offices, Derby.

COUNTY OF LONDON.

The LONDON COUNTY COUNCIL invites Tenders for the Supply of 4200 Tons of PROTOSULPHATE of IRON (Commercial Green Vitriol) to the Barking and Crossness Main Drainage Outfall Works.

Tenders, which must be upon the printed forms to be obtained upon application to the Council's Chief Engineer, at the County Hall, London, S.W., must reach the Clerk of the Council not later than 10 a.m. on TUESDAY, APRIL 30th, 1907, and must be marked "Tender for Protosulphate of Iron." The Council does not bind itself to accept the lowest or any tender.

Full particulars, and also information as to the conditions to be observed by tenderers, will be given in the "London County Council Gazette" of April 15th, 1907. The Gazette, which is published weekly, contains particulars of all Tenders invited by the Council, and can be obtained from Messrs. KING & SON, 2 & 4, Great Smith Street, S.W., price 1d. (post free 1½d.) an issue, or for the whole year a prepaid subscription of 6s. 6d.

G. L. GOMME,
Clerk of the London County Council.

County Hall, Spring Gardens, S.W.,
April 11th, 1907.

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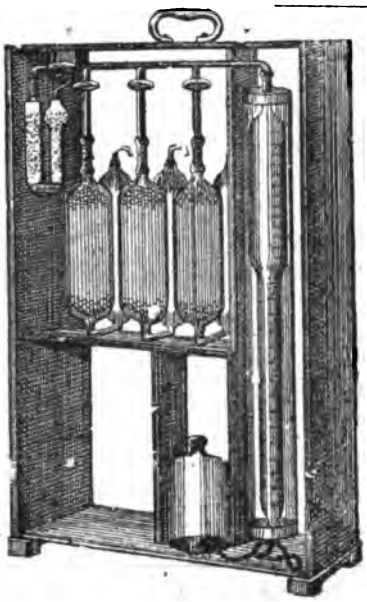

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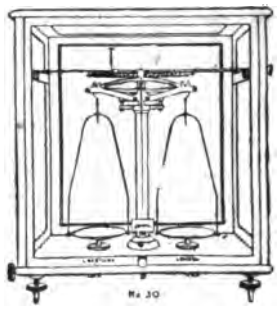

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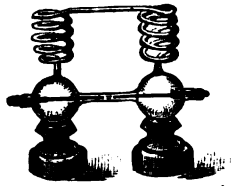

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VOL. XCV., No. 2474.

ON THE CALCULATION OF PHYSICO-CHEMICAL CONSTANTS.

By H. STANLEY REDGROVE, F.C.S.

IT has been found that the "ethylene" linkage exerts an influence on certain physico-chemical properties (*e.g.*, molecular refractivity, heat of combustion, &c.); it is therefore probable that the ordinary C.C link has also some influence; for example, the value of :C: in CH_4 is different from its value in C_2H_6; similarly the values of 6:C: in cyclo-C_6H_{12} and normal-C_6H_{14} are also different; at least the opposite may not be assumed. It is also most probable that the value of H. in H_2 is not the same as that of H. in an hydrocarbon.

This being so, the alleged atomic physico-chemical constants are incorrect, and, so far as our present knowledge goes, unobtainable.

The proof of this statement in the case of carbon and hydrogen follows. The hydrocarbons only have been considered, but the method may similarly be applied to other compounds.

Nevertheless, the examination of physico-chemical constants does show us the tenability of any particular formula for a body; the method of application is also outlined hereinafter.

Let H be the value of an H atom and the link joining it to C.

Let C be the value of a C atom, not including the value of its links.

Let L_1, L_2, and L_3 be the values of the C.C, C:C, and C:C links respectively.

If the constants for methane and three other hydrocarbons (one of each of the ethane, ethene, and ethine groups) are found experimentally, the value of the following may be calculated:—

$2H - L_1 = \beta$, $4H - L_2 = \gamma$, and $6H - L_3 = \delta$, and the value of $C + 4H = \alpha$ is known.

If a larger number of experimental results are found, a mean may be struck and greater accuracy obtained.

It is proposed to call the above the "fundamental constants" (for C and H).

We have here four equations involving five unknowns; these cannot be solved unless another equation not derivable therefrom can be obtained.

To see if this be possible it is necessary to develop a general expression for all hydrocarbons.

$nC + (2n+2)H + (n-1)L_1$ represents all open chain saturated hydrocarbons. The removal of 2H causes the replacement of a C.C link by a C:C link; thus, $a(2H + L_1)$ may be replaced by aL_2.

$nC + 2(n+1-a)H + (n-1-a)L_1 + aL_2$ represents therefore all open chain hydrocarbons not containing C:C links. These are obtained by replacing $b(4H + L_1)$ by bL_3.

$nC + 2(n+1-a-2b)H + (n-1-a-b)L_1 + aL_2 + bL_3$ represents therefore all open chain hydrocarbons.

Ring hydrocarbons can be obtained by the replacement of $2p$H by pL_1.

$nC + 2(n+1-a-2b-p)H + (n+p-a-b-1)L_1 + aL_2 + bL_3$ is therefore a general expression for all hydrocarbons.

$$nC + 2(n+1-a-2b-p)H + (n+p-a-b-1)L_1 + aL_2 + bL_3$$
$$= (nC + 4nH) + [(n+p-a-b-1)L_1 - 2(n+p-a-b-1)H] + (aL_2 - 4aH) + (bL_3 - 6aH)$$
$$= n\alpha - (n+p-a-b-1)\beta - a\gamma - b\delta.$$

Therefore the expression for any hydrocarbon can be expressed in terms of the fundamental equations; consequently, no equation not derived therefrom can be obtained; therefore the equations are not capable of solution; that is to say, neither the atomic physico-chemical constants nor the value of the carbon linkages can be obtained.

The proof can be extended to other compounds.

The above identity enables us at once to write the formula of any hydrocarbon in terms of the known fundamental constants, and the theoretical value thus obtained can be compared with the value found experimentally.

As an example, the interpretation of the heat of combustion of benzene is appended, as this is a contested point. This method it will be noticed is vastly different from the forcing of a before-conceived result so often adopted.

From the heats of combustion of various hydrocarbons (Thomsen) the "fundamental constants" are found to be: $\alpha = 211{\cdot}9$ Cals., $\beta = 53{\cdot}5$ Cals., $\gamma = 90{\cdot}9$ Cals., $\delta = 114{\cdot}4$ Cals.

Kekulé's formula for benzene is represented by—

$$6C + 6H + 3L_1 + 3L_2 = 6\alpha - 3\beta - 3\gamma = 838{\cdot}2 \text{ Cals.}$$

Ladenburg's formula for benzene is represented by—

$$6C + 6H + 9L_1 = 6\alpha - 9\beta = 789{\cdot}9 \text{ Cals.}$$

Heat of combustion for benzene found by Thomsen is 788 Cals.

It must not be concluded that these facts are totally in favour of Ladenburg's formula, for the following reasons:

1. Owing to experimental difficulties we cannot place very great reliance on the experimental data.
2. Claus's old diagonal formula is also represented by $6C + 6H + 9L_1$.
3. It is not inconceivable that some other little known form of linkage (such as the central bonds) may not give an equally good theoretical value.

The Polytechnic, Regent Street, W.

AN INVESTIGATION TO DETERMINE THE PAPER-MAKING QUALITIES OF SHORT COTTON FIBRES.

By CLAYTON BEADLE and HENRY P. STEVENS.

THE ultimate fibres of those materials used in the manufacture of the very best classes of papers, notably cotton, linen, hemp, ramie, manilla, &c., are under ordinary circumstances reduced in length in the process of manufacture, however carefully the material is manipulated with the object of preserving the length of the fibre. From a careful investigation of this subject, by taking measurements of the length of the fibres at different stages of the beating, as in the case of flax, hemp, cotton, and linen rags, the authors were led to conclude that it is impossible to preserve the ultimate length of the fibre; thus, in the case of flax fibre, for instance, as used in the manufacture of the strongest papers now produced, each ultimate fibre is reduced by being cut into at least four or five pieces before being reduced to the condition of pulp. This, moreover, is the prevailing opinion and experience of practical paper-makers, but it has hitherto lacked evidence in the shape of actual measurements under the microscope. The authors have, however, recently discovered that under certain conditions the cotton fibre can be reduced to pulp with little or no reduction in the initial length of the ultimate fibre.

For the purposes of this investigation a short-fibred cotton was selected, the cotton chosen being that which is partially removed by delinters from cotton-seed after the ginning operation. This fibre was boiled under pressure in a Jena beaker placed in a digester; the conditions of the boiling being varied to determine the most favourable conditions for the production of a product available for paper-making. The results of these digester trials are summarised in Table I. The time taken to reach the pressure mentioned on the table is about one hour. The time

TABLE I.—*Summary of Boiling Trials.*

No.	Date.	Amount taken, air dry.	Pressure.	Time.	NaOH on fibre.	NaOH on solution.	Bleach on fibre.	Yield of bleached half-stuff, air-dry.	Ether extract.	Alcoholic extract.	Total extract.	Ash.
		Grms.	Lbs.	Hours.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1.	5/12/06	100	15	4	8	1	2·5	—	0·17 (*a*)	0·53 (*b*)	0·7	0·5
2.	—	100	15	4	8	1	2·5	—	0·22 (*a*)	0·54 (*b*)	0·76	—
3.	—	195	15 / 56	1 / 3	10	2	2·5	—	0·11 (*b*)	0·50 (*a*)	0·61	0·48
4.	12/2/07	300	15 / 56	1 / 3	10	2	2·5	67·0	0·116 (*a*)	0·41 (*b*)	0·526	0·24
5.	13/2/07	300	45	4	10	2	2·5	68·0	0·15 (*c*)	—	—	0·4
6.	14/2/07	300	45	4	10	2	2·5	70·0	0·126 (*d*)	—	—	0·4
7.	15/2/07	300	45	4	10	2	5·0	—				
8.	18/2/07	300	45	4	10	2	5·0	66·3				

(*a*) First extraction. (*b*) Second extraction. (*c*) Paper A. (*d*) Paper B.

TABLE II.—*Lengths of Fibres.*

Boiled and bleached cotton, before beating.			Paper A.			Paper B.		
Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.
3·6	0·9	1·2	2·9	1·4	2·4	3·1	1·7	2·4
1·7	2·1	1·9	1·4	1·7	2·1	1·2	1·7	4·0
0·9	2·4	4·3	2·4	1·2	1·2	1·2	1·7	0·9
2·1	2·1	3·8	3·8	3·1	2·9	0·9	1·9	0·5
1·7	1·9	1·9	2·9	1·4	4·8	2·9	2·1	1·0
3·1	2·1	2·6	1·4	1·4	1·7	1·4	4·0	1·7
1·9	5·0	5·0	4·3	2·1	2·6	1·0	2·1	1·7
4·3	0·7	0·7	1·0	2·4	0·9	0·9	1·7	0·7
2·9	1·4	2·4	1·2	1·0	2·4	1·2	0·9	0·3
1·0	1·4	1·4	0·7	1·7	2·6	1·2	3·3	4 0
4·5	3·3	0·7	4·8	2·4	0·7	1·0	1·0	1·2
1·2	4·5	1·9	3·6	3·8	1·7	3·3	1·4	0·7
3·1	0·5	3·6	0·7	3·1	3·6	2·4	0·7	0·9
1·4	2·1	1·0	1·2	1·7	1·9	1·9	0·5	1·0
1·2	3·2	0·5	3·1	2·4	1·2	2·1	1·4	1·7
Mean .. .. .. 2·31	2·25	2·19	2·36	2·05	2·28	1·71	1·74	1·51
Mean of three columns = 2·25			2·20			1·65		

TABLE III.

	Mean lengths of fibre from 45 readings.	Reduction in length of fibre on beating. Per cent.	Calculated number of fibres cut during beating.
Boiled and bleached cotton, before beating	2·25	—	—
Boiled and bleached cotton, when beaten for Paper A ..	2·20	2·2	1 in 23
Boiled and bleached cotton, when beaten for Paper B ..	1·65	26·6	1 in 3

TABLE IV.

1.		2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
							Per cent.	Mm.	Lbs.	Lbs.	Lbs.	Lbs.
Sample A.	1.	1·05	3·17	2·12	0·106	1·156	9·2	0·096	15·92	16·58	9·11	0·99
,,	2.	1·07	3·05	1·98	0·099	1·169	8·5					
,,	3.	0·92	1·61	0·69	0·0345	0·9545	3·7	0·084	10·35	12·32	4·88	1·32
,,	4.	1·07	2·07	1·00	0·050	1·120	4·5					
,,	5.	1·06										
Sample B.	1.	1·00	1·69	0·69	0·0345	1·0345	3·3					
,,	2.	1·17										
,,	3.	1·20	2·23	1·03	0·0515	1·2515	4·1					
,,	4.	1·32	1·86	0·54	0·027	1·347	2·0					
,,	5.	1·26	2·10	0·84	0·042	1·302	6·4	0·084	15·30	18·59	6·59	1·03

Headings to Columns of Table IV.

1. Reference No. of sample, &c.
2. Air-dry weight of water-leaf.
3. Wet weight after dipping in 5 per cent gelatin solution.
4. Weight of 5 per cent gelatin solution taken up by water-leaf.
5. Air-dry weight of gelatin taken up by paper.
6. Air-dry weight of paper after sizing with gelatin.
7. Percentage of air-dry gelatin calculated on air-dry weight of sized paper.
8. Thickness (in mm.) of paper from average of five thicknesses, measured with fraction micrometer.
9. Mean strength of paper after sizing, being the result of two tests in each direction of the web.
10. Mean strength, corrected to 0·1 mm. thickness.
11. The additional strength due to sizing with gelatin (expressed on sheets 0·10 mm. thickness).
12. Increase in strength due to gelatin after deducting the strength due to water-leaf and reducing to strength per each 1 per cent gelatin on paper 0·10 mm. thickness.

of boiling is reckoned from the time the recorded pressure is reached. The percentage of soda on the weight of the fibre, as well as the strength of the soda solution, is stated on the table.

After blowing off and discharging from the boiler, the product was in each case thoroughly washed on a wire sieve and then mixed with a solution of bleach powder equal to twenty times the weight of the fibre and left until a good white colour was produced. The product was then thoroughly washed, carefully bone-dried, and, after sufficient exposure to the air, was weighed in its air-dry form, from which weight the percentage yield was calculated. The yield was found to vary between 80 and 66 per cent, according to the quality of the raw fibre, and the air-dry moisture of the bleached product to be about 7 per cent. The air-dry bleach fibre was extracted for four hours with ether in a Soxhlet and subsequently for four hours with alcohol, the results of which tests are recorded in Table I., together with the percentage of ash found in the bleach product.

The product from boilings 5, 6, and 7, after thorough mixing, was beaten in a small hollander of 200 grms. capacity and converted into paper. The first lot (A) was beaten with the object of conserving the length of the fibre as far as possible; the second lot (B) was beaten so as to somewhat reduce the length of the fibre.

The beating of A was started at 11 a.m. with the "roll" off the plate; the roll was lowered just to brush the fibres at 11.30 a.m.; at noon, when the noise of "brushing" had disappeared, the roll was further lowered so as to "brush" again, and left until (at 1 p.m.) fibres were completely separated. Total time in beater was two hours.

The beating of B was started at 2.10 p.m. with roll just brushing; the roll was further lowered (at 3.10 p.m.) so as to brush harder; at 3.30 p.m. the roll was further lowered, so as to just touch the plate and reduce length of fibres; and at 4 p.m. was further lowered, so as to beat harder, and so left until finished at 4.10 p.m. Total time in beater was two hours.

The beaten stuff A was run off on Marshall's miniature paper machine, which is a Fourdrinier paper machine complete in every detail. The behaviour of the stuff was very carefully watched. The stuff worked very "free" on the machine, *i.e.*, it parted very readily with its water, as a paper would do in the manufacture of blottings.

In the case of B, when run on the paper machine it was observed that the pulp worked sufficiently "wet" for all ordinary purposes of manufacture, and held the water up to the "dandy," so that the fibres could be well knitted together by the shake of the paper machine. Both papers looked well.

An average sample of the cotton fibre before beating was carefully secured from different parts of the bulk and intimately mixed. A number of fields were examined under the microscope, from which measurements of length were made, as shown in the first three columns of Table II.

Papers A and B were carefully reduced to the condition of pulp without reducing the length of fibre, and similarly mounted for measurement under the microscope, the results of which are also given on Table II.

Each set of measurements consists of three columns of fifteen measurements each. The average of each column differs only slightly. At the bottom of the table is given the figure for the forty-five readings recorded in each set.

Table III., which is prepared from above averages, shows that the reduction of length by beating in the case of A is practically nil, and in the case of B only about 27 per cent. From these figures it is evident that, in the case of paper A, only 1 fibre in 23 is cut by the beater knives; and, in the case of B, about 1 in each 3 fibres. Contrast this with the beating of ordinary cotton and linen rags for the production of "long stuff," where each fibre is cut on an average into five or ten pieces. These results prove to the authors' satisfaction that such short-fibred cotton can be reduced to the condition of pulp without reducing the length of the fibres; or, in other words, the ultimate fibres can be separated from one another and suspended in their watery medium for conversion into paper without being cut asunder. This, however, has never in the authors' judgment been done in conversion of long-fibred waste cotton into beaten stuff, nor is it possible to do so in the conversion of cotton rags into pulp, because, during the process of unravelling the latter or of undoing the work of the spinning and weaving operations to secure the suspension of the individual ultimate fibres in their watery medium, it is impossible to avoid the cutting asunder of the ultimate fibres into several individual pieces. It is noteworthy that, by careful brushing in the beater and by avoiding the beating operation proper and by using short fibred cotton in the manner above described, paper can be produced consisting of intact ultimate cotton fibres of such length that they are suited to the work of the papermaker. The authors regarded it of interest to examine such paper for physical qualities.

Accordingly, unsized paper from papers A and B were submitted to physical tests for strength, with the results as follow:—

Unsized paper A and B—

	A.	B.
Mean strength of machine direction (lbs.) ..	9·0	10·0
Mean strength of cross direction (lbs.) ..	3·5	6·25
Mean of both directions	6·25	8·12

Mean thickness of five sheets .. .. .. A = 0·084 mm. B = 0·074 „

Mean strength of each paper corrected to 0·1 mm. thickness .. ..

$$A = \frac{6{\cdot}25 \times 0{\cdot}100}{0{\cdot}084} = 7{\cdot}4 \text{ lbs.}$$

$$B = \frac{8{\cdot}12 \times 0{\cdot}100}{0{\cdot}074} = 11{\cdot}0 \text{ „}$$

Five sheets of A and B were impregnated with a 5 per cent solution of gelatin at 110° F., containing a small amount of alum, and passed between squeezing rollers to squeeze out the excess and hung up to air-dry, after the manner employed for tub sizing in the paper mill; the sheets were weighed immediately before and after sizing, from which the amount of gelatin, as retained by the air-dry paper, was calculated.

Certain of these sheets—A1, A3, and B5—were tested for strength, total stretch, and permanent stretch, with the results as follow:—

Sized paper (A1) tested for strength as follows—

Machine direction. Lbs.		Cross direction. Lbs.	
1	19·6	3	12·0
2	19·5	4	12·6
Mean ..	19·55		12·3

Mean of the two directions .. .. .. = 15·92 lbs.
Average thickness of five sheets .. .. = 0·096 mm.
Mean strength per 0·10 mm. of thickness = 16·58 lbs.

Sized paper (A3) tested for strength, total stretch, and permanent stretch as follows:—

		Strength. Lbs.	Total stretch. Per cent.	Permanent stretch. Per cent.
Machine direction ..	1.	13·7	7·6	3·0
	2.	14·3	8·4	4·0
Mean		14·0	8·0	3·5
Cross direction	3.	6·3	7·2	3·8
	4.	7·1	9·4	5·0
Mean		6·7	8·3	4·4
Mean of both directions ..		10·35	8·15	3·95

Average thickness of five sheets .. .. .. 0·084 mm.
Average strength of both directions of sheet per 0·10 mm. thickness .. .. 12·32 lbs.

Sized paper (B5) tested as follows :—

		Strength. Lbs.	Total stretch. Per cent.	Permanent stretch. Per cent.
Machine direction ..	1.	18·2	8·0	4·2
	2.	16·7	9·4	4·6
Mean		17·45	8·7	4·4
Cross direction	3.	12·4	12·0	6·0
	4.	11·8	11·6	5·2
Mean		12·1	11·8	5·6
Mean of both directions ..		14·77	10·25	5·0

Average thickness of five sheets .. .. .. 0·084 mm.
Mean strength per 0·01 mm. thickness .. 17·59 lbs.

For purposes of comparison, the strength is finally expressed on paper of 0·1 mm. thickness and 25 mm. wide. Tests on the water-leaf papers show that paper with the short fibre has the greater factor of strength, due no doubt to the fact that the hydration of the fibre from the extra beating has increased its felting qualities. Here we have an exemplification of the apparent anomaly of increase in strength accompanying decrease in ultimate length of fibres. Column 10 gives some idea of the relative strengths of these papers, and goes to show that, in the case of B, although the ultimate fibre is reduced in length, yet it gives a greater breaking strain than unreduced fibre A3 for papers of the same thickness; and, furthermore, in the case of A1 and A3 (Columns 8 to 10), it appears that a paper of greater thickness gives a greater factor of strength.

This latter confirms the observations made by one of us as applied to papers consisting of pure linen, namely, that the greatest factor of strength is not obtained on the thinnest papers, but on fairly thick papers (Beadle, "The Fibrous Constituents of Paper," *Technics*, vol. ii., p. 254). Furthermore, it will be noticed (Column 12) that the influence of gelatin sizing is to increase the factor of strength per unit of added gelatin in an inverse ratio to the amount of gelatin. This confirms our previous observations that such is the case provided the amount of gelatin added is not too small (Beadle and Stevens, "The Influence of Sizing upon the Strength of Papers," *Journ. Soc. Chem. Industry*, vol. xxiv., p. 775).

The investigation is a somewhat difficult one, and requires further research on these points, but it goes to show without doubt that, with short-fibred virgin cotton, consisting largely of fibres without collapsed walls and twists and no central canal, excellent papers can be produced with little or no reduction in ultimate length of the fibres, and that such papers give a fair strength, equal at least to those from ordinary rags, and that the gaining in strength due to the sizing of gelatin is very marked. Furthermore, it shows that if such fibres are somewhat reduced in length by the beating, they behave on the Fourdrinier machine like those prepared from rags, and possess excellent felting qualities; in fact, the paper produced from such a material is, in the authors' opinion, as good in texture, appearance, and other qualities as that produced from cotton rags as used in the manufacture of high quality rag-papers.

The authors wish to express their indebtedness to Messrs. T. J. Marshall and Co., of Stoke Newington, for the use of their miniature beater and paper machine for the purpose of this investigation, and to their pupil, Mr. H. C. Potter, for his assistance in connection with the chemical tests and microscopical examinations.

Royal Institution.—On Saturday next, May 4th, at 3 o'clock, Professor W. C. McIntosh begins a course of two lectures on "Scientific Work in the Sea Fisheries." The Friday Evening Discourse on May 3rd will be delivered by Sir James Crichton-Browne on "Dexterity and the Bend Sinister," and on May 10th by Signor Come Giacomo Boni on "Recent Excavations on the Forum Romanum and the Forum Ulpium." The Annual Meeting will be held on May 1st at 5 o'clock.

THE ELEMENTS OF THE YTTERBIUM GROUP.

PART I.

By C. AUER v. WELSBACH.

When more than twenty years ago I discontinued my researches on the earths of gadolinite from Ytterby, I was convinced that the investigation of the earths of the ytterbium group would lead to conclusive results only when the experiments were performed on a large scale.

I hoped to further this branch of chemical research by the results of my labours undertaken from a technical point of view. The most valuable raw material was coming into the market in quantities which were increasing from year to year. But the increase of scientific knowledge was not keeping pace with this abundance of material, and although many chemists were devoting themselves to this subject, comprehensive and fundamental work was still not often to be met with.

So about six years ago I decided with proper equipment again to take up researches on the earths of the ytterbium group.

After a year's work, from many observations I was enabled to draw the conclusion that almost all the elements of the ytterbium group, as they have been hitherto described by chemists, are complex substances, and that the isolation of the actual elements is within the limits of possibility.

Thus a definite, if distant, goal was put before my experiments. I have not yet reached it; for some of the new elements have so far obstinately resisted preparation in the pure state. Thus this is the case with one of the holmium elements, which must form colourless salts, as well as with the element dysprosium, which is chemically most closely allied to it. But there can be hardly any doubt that ultimately these substances will be prepared in the pure state, and that it is only a question of time.

The final results of these experiments I shall publish in a series of separate articles, as they seem to me to offer general interest.

In the following pages I shall describe the preliminary researches as well as the process of separation, as far as they relate to the preparation of salts of ytterbium, erbium, holmium, and dysprosium.

The Working up of the Raw Material.

The raw material consisted of half a ton of raw ytterbium oxalate, which had been prepared from monazite by the Austrian Incandescent Gas Company.

It contained a fair amount of cerite earths, a tolerably large quantity of thorium, and some phosphoric acid.

As in my earlier articles I have repeatedly described the working up of the raw earths I shall now call attention only to the most important parts of the separation process.

The slightly damp oxalates were spread out in thin layers in shallow iron vessels, and then heated to a red heat with free access of air in a large muffle. The oxides, which contained carbonate, were dissolved in nitric acid. The oxides containing much carbonate were made into a paste with water, and were then added to the clear slightly acid nitrate solution in corresponding quantities in order to separate the cerium and thorium, and the whole digested for a long time on the water-bath. The precipitate formed was washed with water, dissolved in excess of hot nitric acid, and ammonium nitrate was added. After cooling, a red cerium ammonium nitrate, containing a little thorium, crystallised out. By concentrating the liquor more cerium salt could be obtained, until finally at high concentrations yellow thorium-cerium-ammonium nitrate separated out.

The mother-liquor of the thorium-cerium salts, after being much diluted with water, was precipitated with oxalic acid, and the oxalates treated as above.

This process was repeated a few times. The meta salts which separated contained no scandium, as a subsequent examination showed.

From the liquors drawn off the meta salts, which were almost free from cerium, thorium, iron, uranium, &c., I

separated directly, without warming, the ytterbium elements as basic nitric acid salts by the oxide process.

This was quite easy as long as the solution was of the right concentration and the oxides added were sufficiently finely divided.

To carry out this process, which enables large quantities of liquor to be worked up without great trouble, the oxides made into a paste with water are added by degrees to the nitrate solution and the whole allowed to stand until the decomposition of the oxides is quite finished; at the most this takes only a few hours. The basic nitric acid salts formed readily settle as a faintly pink precipitate. They are collected on a filter, and washed under pressure with water containing a small percentage of nitric acid.

After repeating this process five or six times the mother-liquor contained only a little erbium. It was put aside. Then one half of the basic nitric acid salts separated by the first precipitation was converted into nitrate by treating with water and allowing the whole to stand until the formation of the perbasic salts was ended. By cautiously adding nitric acid a clear nitrate solution free from acid was easily obtained in the cold.

From this solution the other half of the basic nitric acid salts was re-crystallised.

Using the mother-liquor of the first fraction the second was worked up similarly, and so on, till the final mother-liquor showed only a faint erbium spectrum. This liquor was again set aside. Thus the first series of the basic nitric acid salts was formed.

In the mother-liquor of the following series the amount of erbium steadily increased. For example, the mother-liquor of the tenth series had a deep pink colour owing to the large amount of erbium it contained.

In order to get the erbium fraction as free as possible from yttrium, the separation process was continued up to the twenty-first series. The fractions of this last series were not further separated from one another.

The first were a purer pink and were richer in ytterbium than the last. The essential constituents, besides erbium, were ytterbium, holmium, and dysprosium. The total weight was about 30 kilogrms.

For the further separation of these substances I employed a new method which I shall now describe in outline.

The Method of Separation.

The earths of the ytterbium group as oxalates form double salts with ammonium oxalate, of which the richest in ammonium oxalate is soluble without dissociation in a saturated solution of ammonium oxalate. The salts of the different earths exhibit considerable differences in solubility; for instance, ytterbium ammonium oxalate is more than ten times as soluble as the corresponding holmium salt. As the temperature rises the solubility of this double salt increases to a remarkable extent, as long as the ammonium oxalate solution is saturated with ammonium oxalate. When these solutions are cooled it may be seen that the more soluble salts show the phenomenon of supersaturation to a much higher degree than the less soluble.

If now a mixture of the pure ytterbium oxalates is dissolved in boiling concentrated slightly ammoniacal ammonium oxalate solution, and the solution is allowed to cool slowly, certain precautions being observed, a series of fractions is readily obtained, which differ very much from one another; while the first fraction is very rich in holmium, the last, the mother-liquor, contains besides a little erbium only large quantities of ytterbium, and thus is free from holmium. In the solution of the more soluble double salts the less soluble salts are either insoluble or dissolve only with difficulty.

These and similar observations induced me to investigate further the behaviour of these double salts under different experimental conditions. From these experiments I found that a new method of separation for the ytterbium elements could be based upon the fractional crystallisation of the ammonium double oxalates, a method which, if it offered technically many difficulties, nevertheless would be better and more convenient than any process ordinarily employed.

After I had settled all the details of the process by working up a small quantity of pure ytterbium oxalate amounting to only a few hundred grms., I proceeded to a repetition of the method on a large scale.

At this point I must remark that the sodium double salts behave like the ammonium salts, but that they are not suitable for separating the earths, chiefly on account of the difficulty of dissolving them. The potassium salts, on the other hand, behave quite differently. They are usually so soluble and crystallise so well that the separation effected by the process is very trifling under similar experimental conditions.

Details of the Separation Process.

The basic nitric acid salts, the preparation of which I have described above, contained a small amount of meta-salt which had accumulated more especially in the first fractions. To separate these compounds the basic nitric acid salts were digested continuously with water, concentrated nitric acid gradually added to the cooled mixture of perbasic salts and nitrates, until the perbasic salts were almost entirely dissolved; the fairly concentrated turbid nitrate solution was then filtered.

The clear solution was acidified, and after being greatly diluted with water was precipitated with warm saturated ammonium oxalate solution. The oxalate precipitates containing ammonium oxalate, which generally form fine precipitates yielding no concretions, were filtered and washed.

The separation process is carried out as follows:—The wet oxalate precipitates are made into a uniform thin paste with water. As much of this paste as will dissolve quickly and easily is introduced into a boiling concentrated ammonium oxalate solution containing a little free ammonia, meanwhile stirring continuously. If this limit is exceeded, and thus a persistent turbidity is produced in the solution, some solid ammonium oxalate must be added as quickly as possible in order to cause the disappearance of the turbidity. For the precipitates which result owing to a deficiency of ammonium oxalate dissolve again only with great difficulty on boiling for a long time and in presence of a large excess of ammonium oxalate.

The clear beautiful pink solution of the ammonium double oxalates is now slowly diluted while still hot with three times its volume of water or cold saturated ammonium oxalate solution, meanwhile steadily stirring. If any turbidity should result some hot saturated ammonium oxalate solution is added. The solution is then introduced into a previously warmed large porcelain dish, preferably hemispherical in shape, covered with a glass lid, and the liquor allowed to stand on the water-bath, or, better, in a thermostat at about 70° C.

The richer the solution is in dysprosium and holmium the hotter and more concentrated it must be kept. After a few hours the separation of the double salts rich in dysprosium and holmium begins with the crystallisation of the ammonium oxalate.

After twenty-four hours the mother-liquor is drawn off, the same precautions being observed as before, and the crystalline crust forming in the dish is allowed to slide off by inclining the dish.

The mother-liquor is returned to the thermostat and the temperature regulated to about 50° C. This process of allowing to stand in the thermostat, the temperature being gradually lowered, is repeated four or five times. The last mother-liquor is allowed to stand for several days in the cold.

Thus, seven or eight crystal fractions are obtained which show striking differences among themselves. While the first is more yellowish red, the middle ones are pure pink and the last pale pink, while the mother-liquor is almost colourless after standing for some time.

The fractions are now dissolved, if necessary with the

addition of ammonium oxalate, by boiling in as little water as possible, again diluted, and fractionated as above. Then similar fractions are put together, again dissolved, and the process continued, the mother-liquor of the preceding fraction being always used to dissolve each fraction.

The arrangement of the fractions into series is performed according to the spectra of the crystals and not according to the spectra of the liquors, because the crystalline ammonium double oxalates of holmium and erbium have very marked spectra, while those of the fairly dilute solutions, on the contrary, are not sharp. A direct vision spectroscope is used with a very narrow slit, and it is best to work in sunlight or in light from an arc lamp. For those who are not skilled the former is to be recommended, because the Fraünhofer lines greatly assist the identification.

The dispersion and magnifying power of the instrument must be great enough for the D-lines to appear distinctly double. I used for these observations a Browning's direct vision spectroscope, with a slit which could be altered from the side.

From the intensity of the lines shown in a crystal spectrum it is usually fairly easy for a worker who has had experience of the method to draw definite conclusions as to the mother-liquor.

Nevertheless, small errors may be made, but they do not matter much. If, moreover, the worker has been making these observations for some time, the eye gets so keen in observing slight differences of shade that it is generally sufficient to observe the colour of the fractions in diffuse daylight in order to be able to deduce their positions in the series.

After several series the first fractions become paler, and the holmium and dysprosium lines appear more clearly; in the final members, on the other hand, the holmium line $\lambda = 535$ gradually disappears. The fractions become more and more pink in colour. Soon the characteristic spectrum of pure erbium appears.

As the separation is continued in the first fractions the erbium line $\lambda = 540$ in the green, disappears, and their colour becomes light orange-yellow. The difficulty in dissolving them becomes greater and greater, and in order to effect complete solution ammonium oxalate must often be added to the boiling mixture. The fractions containing erbium, at the end of the series, continually get paler. The absorption spectrum gradually changes; the characteristic line in the green disappears by degrees, and a new erbium spectrum, which I shall call "spectrum erbium γ," becomes more and more distinct.

After repeated evaporation the final mother-liquors are colourless. With further fractionation colourless crystal aggregates separate out from it; they contain a large excess of ammonium oxalate.

The liquors are now allowed to stand for a long time in the cold; once more precipitates rich in ytterbium separate out. As soon as the first and last members of the long series become small in quantity they are put back until after several repetitions of the crystallisation process—after many series, as I shall call it for the future—homogeneous products are obtained. The similar fractions are then put together and joined to the series as the extreme members.

In the above outlined description I think I have explained the nature of the separation process as far as it is of scientific interest, and will not therefore give a complete description of the lengthy separation processes themselves, which would only be tedious. I shall merely call special attention to some points which are of importance in the carrying out of the process. The first working up naturally takes place in many parallel series. As the series contained far more erbium than was necessary for the scientific investigation of this substance a large part of the erbium fractions containing a little holmium were put back at the beginning. All fractions were finally united in one chief series. After about forty series the first members of the chief series showed no holmium spectrum; they were put aside. I soon added others to them, and afterwards I regularly excluded each first crystalline fraction from the process. Thus gradually a long series of fractions was formed, which were all more or less different from one another. In addition there were the final mother-liquors put aside from the series, which had been put together every ten series. They were again fractionated systematically, and the fractions obtained added to the others.

The number of fractions had then risen to about one hundred. Together they made an unusually instructive picture. The first fractions put aside were almost white, the following up to about the fifteenth were pale yellow, then they became orange-yellow, while towards the middle they became more and more pink. After the beautiful pink erbium fractions came pale pink fractions, till finally towards the end of the series came the colourless ytterbium salts.

Observed directly in transmitted light the first crystal fractions showed a somewhat altered dysprosium spectrum, besides traces of the spectrum of neodymium. The pale yellow ones gave the normal dysprosium spectrum, the pure orange the holmium spectrum, while the most intensely pink coloured fractions exhibited only the characteristic erbium spectrum.

As the pink colour got paler the erbium spectrum altered, and gradually passed into the spectrum of Er γ. Thenceforward the bands of thulium steadily increased in strength until they reached their greatest intensity in the fractions which were only faintly pink. In the nearly colourless fractions they got fainter and fainter again, not disappearing altogether, however, until the completely colourless ytterbium fractions were reached.

Similar although not such marked differences were exhibited by the nitrate solutions.

The visual examination of the spark spectra led to important results. In the first fractions, which possessed an exceedingly complicated spectrum, lines could be seen which did not appear to coincide with the lines of known elements. The pale yellow and yellow fractions gave a more or less pure spectrum of ordinary holmium, while the orange-yellow, *i.e.*, just those which showed the most intense and purest absorption spectrum of holmium, did not exhibit the characteristic lines of holmium in addition to a usually bright yttrium spectrum; other groups, however, which were very rich in lines, appeared. Among other effects their prevalence made the somewhat pale yttrium spectrum appear as if on a light ground.

In the more decidedly pink-coloured fractions the yttrium spectrum again disappeared. The intensely pink-coloured fractions gave the spark spectrum of erbium. As the fractions got paler the spectrum of ytterbium began to appear more clearly until it reached its full brightness in the colourless fractions.

Important results were also obtained from the thorough investigation of the final mother-liquors, which naturally contained the most easily soluble parts of the double oxalates. The first of these liquors, which I examined at the beginning of the separation process, contained thorium as meta-salt, also some uranium and iron as well as other substances, which had originated partly from the large quantities of water used and partly from the ammonium oxalate; amongst them were aluminium hydroxide, silicic acid, alkalis, &c.; of the rare earths only some ytterbium and a minute quantity of scandium could be detected.

The other final mother-liquors I also subjected to a careful examination. After diluting them with water, nitric acid was carefully added until all the oxalates of the earths had been separated. The liquid filtered off from the oxalates was evaporated and the residue ignited. The residue left after ignition contained, besides much silicic acid and aluminium hydroxide, a small amount of platinum metals and elements allied to tin, as well as a very small quantity of rare earths. I added the last, after I had again converted them into oxalates, to the oxalate precipitate first obtained. These oxalates also contained some thorium, but curiously enough no scandium. After the thorium had been separated I again dissolved the oxalates of the earths in ammoniacal ammonium oxalate solution,

filtered from the undissolved silicic acid and fractionated the solution carefully until a small residue was obtained. This should now contain the purest ytterbium. But this conclusion was contradicted by the spectral examination; for the spark spectrum, which was free from the lines of foreign bodies, showed, when compared with the ordinary ytterbium spectrum, most striking differences. These differences are the first definite indications of the decomposability of ytterbium.

I have omitted to give representations of the different spectra with this article because I shall go more fully into all the characteristic spectra in the special articles mentioned previously.—*Monatshefte fur Chemie*, xxvii., No. 8, 935.

A STUDY OF THE METHODS FOR THE DETERMINATION OF ESTERS, ALDEHYDES, AND FURFURAL IN WHISKY.*

By L. M. TOLMAN and T. C. TRESCOT.

(Concluded from p. 185).

Determination of Aldehydes.
By L. M. Tolman.

The method for the determination of aldehydes as provisionally adopted by the Association was found to be entirely unreliable—and, in fact, the reagents as given were not correct, as they reacted with alcohol free from aldehydes. The reason for this was that there was not enough sulphur dioxide in the solution. The amount of sulphur dioxide in the solution greatly affects its sensitiveness, and the main point to be determined was how to prepare a solution that would not react with pure alcohol and was still sensitive enough. By experimenting with a number of mixtures, it was found that a reagent that contained 5 grms. of sulphur dioxide to the litre gave only the slightest tinge of colour with the pure alcohol and was sensitive to 0·0001 grm. of aldehyde in 50 cc. From this it can be seen that it is very necessary that the amount of sulphur dioxide present should be accurately determined, and that the use of a solution of sodium bisulphite of a definite specific gravity is not to be relied on in preparing this reagent. If the sulphite is to be used, its strength in sulphurous acid should be determined by use of a standard solution of iodine. Another objection to the Association method was the fact that the test is made in a 30 per cent alcohol solution. The objection to using this strength of alcohol is that when most pure whiskies are diluted to this alcoholic strength they are turbid, and this turbidity greatly interferes with the reading of the amount of aldehydes in the colorimeter. The following are the reagents and method finally adopted for our work.

Reagents.

1. *Alcohol Free from Aldehydes.*—This is prepared by first re-distilling the ordinary 95 per cent by volume alcohol over caustic soda or potash and then adding 2 to 3 grms. per litre of *m*-phenylenediamine hydrochloride, and digesting at ordinary temperature for several days or with an upright condenser on the steam-bath for several hours and then distilling slowly, rejecting the first 100 cc. and the last 200 cc.

2. *Sulphite-fuchsin Solution.*—Take 0·500 grm. of pure fuchsin and dissolve in 500 cc. of water; then add 5 grms. of sulphur dioxide dissolved in water, make up to a litre, and allow to stand until colourless.

This solution should be made up in small quantities, as it retains its strength for only a very few days.

3. *Standard Acetic Aldehyde Solution.*—Prepared as directed in Vasey ("Analysis of Potable Spirits," p. 30).

Aldehyde ammonia is taken as the starting-point. Grind this in a mortar with ether and decant the ether, repeating the operation several times, then dry the purified substance in a current of air and finally in a vacuum over sulphuric acid. Dissolve 1·386 grms. of this purified aldehyde ammonia in 50 cc. of 95 per cent by volume alcohol; to this add 22·7 cc. of normal alcoholic sulphuric acid, and then make up to 100 cc. and add 0·8 cc. to compensate for the volume of the ammonium sulphate precipitate. Allow this to stand over night and filter. This solution contains 1 grm. of acetic aldehyde in 100 cc. and will retain its strength.

The standard found most convenient was 2 cc. of this strong aldehyde solution diluted to 100 cc. with 50 per cent by volume alcohol. One cc. of this solution is equal to 0·0002 grm. of acetic aldehyde. This solution should be made up fresh every day or so as it loses its strength.

The method of determining aldehyde is as follows:—Five or ten cc. of the distillate as prepared for the determination of esters are placed in one of the colorimeter tubes and made up to 50 cc. with aldehyde-free alcohol (strength 50 per cent by volume) placed in a water-bath kept at 15° until it reaches the temperature of the bath; then 25 cc. of the sulphite-fuchsin solution, which is also at 15°, is added. The two solutions are thoroughly mixed and allowed to stand in the bath held at 15° for fifteen minutes, and then compared in the colorimeter with standard aldehyde solutions.

Standards containing 0·0005, 0·0010, and 0·0015 grm. of acetic aldehyde are prepared at the same time and under the same conditions. The standard which matches the sample nearest is used for comparison in the colorimeter. If the colour of the sample is stronger than any of the standards, less of the sample must be taken, as colours deeper than that produced by 0·0015 grm. of acetic aldehyde cannot be compared with accuracy.

The regulation of the temperature at which the test is made is of the greatest importance, as the accuracy of the method is entirely dependent on the temperature being held constant at about 15° during the reaction. If this is not done, the colour developed in the blank which should be run with every determination will be so strong as to interfere with the method. In fact, it is impossible to do anything with the method quantitatively without controlling the temperature exactly.

The comparisons in the colorimeter must be made as quickly as possible, as the colour rapidly deepens if the room temperature is much above 15°. The standard aldehyde solution may be checked against the colour glasses of the Lovibond tintometer. In our work, following the exact conditions given above, red No. 5 and blue No. 1·25 combined gave the colour developed by 0·0005 grm. of acetic aldehyde in 50 cc., looking through 42 mm. depth of solution. This, however, should not be taken as a standard, but each analyst should compare his reagents under the conditions under which he is working with the standard glasses. This will be found to be a valuable check on the solutions.

The amount of colour developed by acetic aldehyde under these conditions is not in direct proportion to the percentage of aldehyde present. A standard containing 0·001 grm. develops about three times as much colour as a standard 0·0005 grm. and about one-half the colour of a standard containing 0·0015 grm. This necessitated the preparation of a number of curves, from which Table V. was prepared.

This table is used in the following manner:—The colorimeter tube containing the standard solution is placed in the colorimeter at a definite reading, say at 25. The tube containing the sample is now placed in the instrument and compared with the standard by moving it up and down until the colours match, which is at, say, 19. Now suppose the standard contained 0·0005 grm. of aldehyde and was set in the instrument at a reading of 25, then look in the column under the 0·0005 grm. reading 25 until you come to the place opposite the reading of the sample and

* From the *Journal of the American Chemical Society*, xxviii., No. 11.

TABLE V.—*Calculation of Aldehydes from Colorimeter Readings.*

Sample reading.	0·0005 grm. standard. Reading 15.	0·0005 grm. standard. Reading 25.	0·0010 grm. standard. Reading 10.	0·0010 grm. standard. Reading 20.	0·0015 grm. standard. Reading 10.
	Mgrm.	Mgrm.	Mgrm.	Mgrms.	Mgrms.
10.		0·80	1·00	1·50	1·50
11.		0·76	0·94	1·40	1·40
12.		0·72	0·89	1·30	1·30
13.		0·69	0·83	1·25	1·25
14.		0·67	0·79	1·20	1·20
15.	0·50	0·65	0·76	1·15	1·15
16.	0·48	0·62	0·73	1·10	1·10
17.	0·465	0·60	0·70	1·08	1·06
18.	0·45	0·59	0·685	1·05	1·03
19.	0·43	0·575	0·67	1·03	1·00
20.	0·415	0·56	0·655	1·00	0·97
21.	0·40	0·55	0·64		
22.	0·38	0·54	0·62		
23.	0·365	0·525	0·61		
24.	0·35	0·515	0·59		
25.	0·33	0·50	0·58		
26.	0·315		0·565		
27.	0·30		0·55		
28.	0·29		0·535		
29.	0·28		0·52		
30.	0·27		0·50		
31.	0·265		0·49		
32.	0·255		0·485		
33.	0·245		0·48		
34.	0·235		0·47		
35.	0·23		0·465		
36.	0·22		0·46		
37.	0·21		0·455		
38.	0·20		0·45		
39.	0·195		0·445		
40.	0·19		0·44		
41.	0·185		0·435		
42.	0·18		0·43		
43.	0·175		0·425		
44.	0·17		0·415		
45.	0·165		0·41		
46.	0·16		0·405		
47.	0·155		0·40		
48.	0·15				
49.	0·145				
50.	0·14				

there find the milligrms. of aldehyde, which, in this case, is 0·575. The colorimeter used in this work was that described by Schreiner (*Journ. Am. Chem. Soc.*, 1905, xxvii., 1192—1203), and it was found to be very satisfactory and convenient, being preferred in this work to the Soleil-Dubosq instrument, as it gives a much wider range of comparison. Schidrowitz (*Journ. Soc. Chem. Ind.*, 1902, xxi., 814—819) does not use the distillate for this determination but clarifies the whisky with basic lead acetate, colours his standard slightly with tincture of galls to match the colour of the decolorised whisky, and then treats with the reagent; but this method, while it is applicable to pure whiskies light in colour, cannot be applied to whiskies that are coloured with caramel, as caramel is not removed by lead acetate. Hence, in order to obtain comparable results, it is necessary to work on the distillates in all whiskies.

The claim that aldehydes are formed in the distillation is not substantiated by our experiments on 150 samples of new brandies in which the determination of aldehydes was made on the original sample and on the distillate. The average on the original was 172 mgrms. per litre, while the average on the distillate was 173 mgrms. per litre. These results show several things. First, that the method gives comparable results and results that can be duplicated, as in this work the determination on the original was made on one day and the determination on the distillate the next day. Second, that there is no loss or gain in aldehydes by distillation. Third, that it is an exact method, as is shown by the close agreement of results.

DETERMINATION OF FURFURAL.

By L. M. TOLMAN.

Schidrowitz does not use the distillate for this determination, but follows the same procedure in the determination of furfural as in the determination of aldehydes. The same objection holds in this method, however, as in the aldehyde determination, namely, that the method cannot be applied to all the whiskies on account of the impossibility of removing caramel when present, so that it is better to use the distillate in all cases.

The following are the reagents and the method used for the determination of furfural:—Colourless aniline, hydrochloric acid (sp. gr. 1·125), alcohol free from furfural. The aniline was obtained by re-distilling the ordinary dark coloured aniline. This must be kept in the dark or it will soon become coloured. The ordinary 95 per cent by volume alcohol re-distilled over caustic soda or alkali is practically free from furfural.

Standard Furfural Solution.—Prepare the standard furfural solution by weighing 1 grm. of re-distilled furfural and dissolving it in 100 cc. of 95 per cent by volume alcohol. This strong solution will keep. Standards for use are made by diluting 1 cc. of this solution to 100 cc. with 50 per cent by volume alcohol. One cc. of this solution contains 0·0001 grm. of furfural.

The method for determining furfural is as follows:—Ten or 15 cc. of the distillate as prepared for the determination of esters is placed in a colorimeter tube and diluted to 50 cc. with 50 per cent by volume alcohol free from furfural. The tube is placed in a water-bath kept at 15°, and allowed to remain until it reaches the temperature of the bath. Then 2 cc. of the aniline and 0·5 cc. of the hydrochloric acid are added, and the whole thoroughly mixed. The tubes are left for fifteen minutes in the bath at 15°, and then taken out and read in the colorimeter against standard furfural solutions.

Standards containing 0·0001, 0·0002, and 0·0003 grm. of furfural are prepared and treated in the same manner. The standard which matches nearest the colour in the sample is used for comparison in the colorimeter.

The amount of colour developed by the furfural solutions is in direct proportion to the amount of furfural present, so that calculations can be made directly from the readings.

The temperature greatly affects the reaction, and it should be carefully regulated.

Hydrochloric acid was used instead of acetic acid on account of the fact that the acetic acid available gave a very decided colour reaction, which interfered with the test. Another advantage of hydrochloric acid is that it is more uniform in quality than acetic acid, and in these colour tests it is necessary that the conditions shall remain constant in order to obtain comparable results. The occurrence of furfural in acetic acid or some substance that gives a similar colour reaction with this reagent seems to be quite common, as it has been noted by a number of observers. The substance that gives the test can be destroyed by heating the mixed reagent, but this interferes with its sensitiveness.

In order to settle the question whether all the furfural will be found in the distillate, and also whether there is any formation of furfural in distillation, the determination was made on a number of samples of slightly coloured and colourless spirits, in the original and in the distillate.

The results on 120 samples gave an average of 23·4 mgrms. per litre on the original and of 23·2 mgrms. per litre on the distillate. This shows that there is no loss or gain of furfural by distillation; it also shows that the method is reliable, as the same conditions held in these determinations as in the work on aldehydes.

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

Part II.—Analysis of the Silver, Copper, and Tin Groups.

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 187).

Procedures and Notes.

Analysis of the Silver Group.

Procedure 11.—To the cold aqueous solution of the substance (P. 3) add 4 cc. HCl (1·12) from a small graduate. (White precipitate, presence of *silver group*). Filter, and wash the precipitate with a small quantity of cold water, adding the washings to the filtrate until its volume is about 40 cc. (Precipitate, P. 12; filtrate, P. 21).

Notes.

1. Non-formation of a precipitate proves absence of silver and mercurous mercury, but not of lead (or thallous thallium), since $PbCl_2$ (and TlCl) are fairly soluble in water. Owing to the common-ion effect, the solubility of the chlorides is greatly decreased by the addition of HCl; but 20 to 40 mgrms. Pb (and 5 to 15 mgrms. Tl) may remain in solution, and thus escape detection in this group.

2. Since the subsequent precipitation of the copper and tin groups by H_2S must be made in a dilute HCl solution of known strength, a definite amount of HCl is added at this point, and the solution is diluted to a known volume.

3. The addition of the first few drops of HCl may cause the precipitation of the white oxychlorides BiOCl and SbOCl; but these precipitates dissolve when the rest of the acid is added. If, however, the solution were largely diluted with water, the precipitate might again separate.

4. From an alkaline solution HCl might precipitate many other substances, as described in P. 3, N. 4. Such a solution is therefore first treated with HNO_3 (P. 3).

Procedure 12.—Pour repeatedly through the filter containing the HCl precipitate (P. 11) a portion of 10 to 20 cc. boiling water. Wash the residue thoroughly with hot water. (Residue, P. 15; solution, P. 13).

Procedure 13.—Add to the aqueous extract from the HCl precipitate (P. 12) one-fifth its volume of concentrated H_2SO_4; cool, shake the mixture, and allow it to stand for five minutes. (White precipitate, presence of *lead*). Filter, wash the precipitate with H_2SO_4 (1·20), and then with a little water. (Precipitate, P. 14; filtrate, reject or test for thallium by *P. 13*a*).

Note.

1. $PbSO_4$ is slightly soluble in water, but, owing to the common-ion effect, much less so in dilute H_2SO_4; hence, H_2SO_4 is added in excess to the solution and to the wash-water.

**Procedure* 13*a*.—To test for thallium add to the filtrate from the H_2SO_4 precipitate (P. 13) 2 to 3 cc. KI solution. (Yellow precipitate, presence of *thallium*). If the solution becomes brown, owing to the liberation of free iodine, add a little H_2SO_3 solution.

**Notes.*

1. Thallous iodide is much less soluble than the corresponding chloride, and its solubility is greatly decreased by KI, owing to the common-ion effect. PbI_2 is also difficultly soluble, but cannot be precipitated here, since lead has been removed by H_2SO_4 in P. 13. The presence of even 0·5 mgrm. thallous thallium in 15 cc. of solution may easily be detected in the cold by means of KI. Free iodine oxidises thallous to thallic salts, but these, as well as the iodine itself, are reduced by H_2SO_3.

2. Thallous salts are oxidised to thallic salts rapidly by halogens and *aqua regia*, and slowly by hot concentrated HNO_3. Upon evaporating a thallic chloride ($TlCl_3$) solution and heating the residue at 120°, more or less complete reduction takes place by decomposition into TlCl and Cl_2. Pure thallic salts give no precipitate with HCl, thallous salts a white one; while mixtures of them give yellow precipitates ($TlCl_3.xTlCl$). For these reasons, even when the substance has been dissolved in HNO_3, and the solution has been evaporated as described in P. 4, thallium will be precipitated with this group by HCl if much of it is present.

Procedure 14.—Pour repeatedly through the filter containing the H_2SO_4 precipitate (P. 13) a 10 to 20 cc. portion of a 10 per cent ammonium acetate solution; add to the filtrate a few drops K_2CrO_4 solution and 2 to 5 cc. dilute acetic acid. (Yellow precipitate, presence of *lead*).

Notes.

1. The solubility of $PbSO_4$ in solution of ammonium acetate ($NH_4C_2H_3O_2$) depends on the formation by metathesis of undissociated lead acetate, which is much less ionised than most other salts of the same type. On the addition of a chromate to this solution the much more difficultly soluble $PbCrO_4$ is precipitated, and is not dissolved by dilute acetic acid.

2. This confirmatory test is also applied to the $PbSO_4$ precipitate obtained in the analysis of the copper group (P. 26). In that case the precipitate may also contain bismuth, which would dissolve in ammonium acetate, and give a yellow precipitate on the addition of K_2CrO_4; but this precipitate, unlike the $PbCrO_4$, dissolves readily in acetic acid.

Procedure 15.—Pour repeatedly through the filter containing the residue insoluble in hot water (P. 12) a 10 to 20 cc. portion of NH_4OH (0·96). (Black residue on the filter, presence of *mercurous mercury*). Acidify the filtrate with HNO_3. (White precipitate, presence of *silver*).

Notes.

1. The black residue produced by the action of NH_4OH on Hg_2Cl_2 is a mixture of finely divided mercury with the white mercuric compound $HgClNH_2$. The reaction is expressed by the equation $Hg_2Cl_2 + 2NH_4OH = HgClNH_2 + Hg + NH_4Cl + 2H_2O$. The compound $HgClNH_2$ may be considered to be a derivative of $HgCl_2$, formed by replacing an equivalent of chlorine by the univalent radical NH_2.

2. It is to be noted that mercury will not be in the mercurous state, and therefore will not be precipitated with this group, if the substance has been heated with strong nitric acid or aqua regia.

3. AgCl dissolves readily in NH_4OH, owing to the formation of a soluble complex salt, $Ag(NH_3)_2Cl$, which in solution is largely dissociated into $Ag(NH_3)_2^+$ and Cl^- ions. This complex cation has so slight a tendency to dissociate that in a normal solution of NH_4OH the ratio of its concentration to that of the simple Ag^+ ion is about 10^7.

4. HNO_3 re-precipitates the AgCl from its solution in NH_4OH, owing to the facts that the complex cation is slightly dissociated according to the equation $Ag(NH_3)_2^+ = Ag^+ + 2NH_3$, and that the NH_3 combines with the added acid, forming NH_4NO_3, thus causing the complex cation to dissociate further, until the Ag^+ concentration increases to such an extent as to make the product of it into the Cl^- concentration greater than the solubility product for AgCl.

5. The test is less delicate when the NH_4OH_3 is neutralised with HCl, owing to the solubility of AgCl in strong chloride solutions, which arises, probably, from the formation of a salt with a complex anion, like $NH_4 + AgCl_2^-$.

(To be continued).

* From the *Technology Quarterly*, xix., No. 3 September, 1906.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Ordinary Meeting, March 22nd, 1907.

Prof. J. PERRY, F.R.S., President, in the Chair.

A PAPER by Mr. POCHIN on "*Experimental Mathematics*" was read by the author.

An instrument for describing logarithmic spirals was exhibited, and it was shown how the principal properties of logarithms and of the equiangular spiral may be established as experimental results. A spiral was described with an angle of 45°, and the positions of the radius vector, representing the first ten natural numbers, were drawn in. Cardboard sectors having been cut to fit the various angles, under the successive positions of the radius vector, it was shown that these sectors represented the logarithms of the numbers. Multiplication and division were illustrated by placing the sectors in juxtaposition, so that the angles were added or subtracted, the result being read off directly from the curve. A table of natural logarithms was also prepared from the spiral, by direct measurement with a foot-rule and a protractor graduated in radians. A geometrical analysis was given, confirming the accuracy of the experimental results, and affording an independent proof of the exponential theorem. A second spiral was drawn with an angle $\tan^{-1} M$, thus giving common logs. in terms of the radian; and it was shown that, by using a suitably-graduated protractor or modulus, one system transformed into the other. A Boucher's Circle and a slide-rule were also derived practically from the spiral. The differentials $d \log_e r/dr$ and $d \log_{10} r/dr$ were shown graphically, as well as the properties of the evolute and involute. The paper was put forward as an attempt to show how pure mathematics may be taught experimentally, and in the belief that many boys derive benefit from an alternative treatment which enables them to employ the sense of touch in addition to those of sight and hearing.

Mr. W. A. PRICE expressed his interest in the paper and described an instrument, constructed somewhat on the lines of that described by the author, which could be used to draw the exponential curve $y = ae^{x/b}$. He pointed out that any exponential law was a relation between two quantities changing in arithmetical and geometrical progression respectively. In an exponential curve in which the ordinates change in G.P. and the abscissæ in A.P., the formation of the logarithmic scale can be shown by marking on the scale of abscissæ the corresponding values of the ordinates. Logarithms should form part of the subject of arithmetical and geometrical progressions; the conception of continuous growth being added by interpolation of terms in the usual series.

The CHAIRMAN said the paper was interesting to those acquainted with logarithms and logarithmic spirals, but in his opinion the methods described by the author were not the best for beginners. He pointed out that the early geometers used practical methods to check the results of their theoretical reasoning.

A paper entitled "*Logarithmic Lazy-tongs and Lattice-works*" was read by Mr. T. H. BLAKESLEY.

If two straight rods, AB, CD, are jointed at E, and so related that the extremities ACBD lie in the circumference of a circle, they will fulfil this condition when the angle between them is changed.

Suppose that AE is taken as unity, and that $ED = n$, $EC = m$, m and n being quite independent. Then $EB = mn$ as a consequence.

If another pair of rods, DF, BG, similar to the first pair but bearing the ratio $n : 1$ to it, be jointed at D and B to the first pair, and to the extremities FG of this pair a third pair be again jointed, and a fourth to this, and so on, the ratio of each pair to the preceding one being $n : 1$, the resulting linkage is called by the author a Logarithmic Lazy-tongs.

The points ADG . . . . lie upon an equiangular spiral, whose characteristic angle α is given by the equation—

$$\tan \alpha = \frac{\text{ECA} - \text{EAC}}{\log n}.$$

By opening or shutting the angles at E, the numerator of the expression on the right is varied, but its denominator remains constant. It follows that the characteristic angle of the spiral (α) may be varied at pleasure, by causing the angles at E to change.

A lazy-tongs constructed as above is said to be in the n direction. It is clear that any of the four sides, AC, CB, BD, AD, might be chosen as that to which the next pair of rods is to be attached, care being taken to make the ratio correspond to the direction chosen.

If CB is chosen the ratio must be $m : 1$, and a lazy-tongs in the direction m will result, the angular shift at each step being $\overline{\text{EAD} - \text{EDA}}$.

Suppose pairs added in the m direction to both CB and BF; then it is easy to see that these two pairs will have, in addition to B, another common point, viz., that which is homologous to B in the m direction. In fact the same pair is arrived at whether by moving once in the n direction and then once in the m direction, or *vice versâ*. It is clear that a joint may be added at the common point, and that the rule is a general one, and that all plane space may be occupied by such a linkage, which is called a Logarithmic Lattice-work. Such a lattice-work moves so that the angles at E, and points homologous, will remain equal.

An equiangular spiral also passes through AB, and points homologous in the mn direction. Its characteristic angle α is such that—

$$\tan \alpha = \frac{\overline{\text{BCA} - \text{ADB}}}{\log mn}.$$

Circles and straight lines, being limiting cases of equiangular spirals, will therefore occur with some arrangements. For instance, if $mn = 1$, the curves in the mn direction are circles.

If the n curves are circles, by n being made equal to unity, the angle EAD is equal to EDA; and the difference between these angles being then zero, there will be no angular shift in the m direction, and the m curves will therefore be straight lines.

The author indicated how, by controlling the three variables mn and the angles at E, a geometrical solution of such problems as occur in cables subject to alternating currents may be reached.

Mr. W. A. PRICE pointed out that the principle of extending a quadrilateral by constructing similar and similarly disposed figures on the sides, and thus covering an indefinite area, was not confined to inscribable quadrilaterals nor even to plane ones. A gauche quadrilateral with its diagonals is a tetrahedron, and may be regarded as contained by three pairs of opposite edges. Any two of these pairs may be used to originate a set of quadrilaterals on the author's plan, which will lie on the surface of a helicoid, and whose sides and angular points will describe helical spirals. There will be three sides each of two pairs of edges from each of which may be developed a helicoidal surface with its families of helical spirals; so that from a single gauche quadrilateral three helicoids may be developed.

Mr. R. J. P. ROBERTS exhibited a Compensated Micromanometer, described in the *Proceedings of the Royal Society*, Sect. A, vol. lxxviii.

A paper by Mr. GARRETT on "Electrical Conduction produced by heating Salts" was postponed.

NOTICES OF BOOKS.

Introduction to Physical Chemistry. By James Walker, D.Sc., Ph.D., F.R.S. Fourth Edition. London: Macmillan and Co., Ltd. New York: The Macmillan Company. 1907.

This introduction to physical chemistry demonstrates perhaps for the first time in the English language how profitable the study of this branch of chemistry can be made to students whose knowledge is only quite elementary, provided that sufficient care is taken to emphasise the connections between ordinary chemical knowledge and the new conceptions, and to treat the subject practically. Such being the case, it is not surprising that the book has been widely adopted in science schools and colleges, and that a new edition has been called for. In this, new data have been substituted for old when further work has shown that the latter were inaccurate, and chapters have been added on Atomic and Molecular Dimensions, and on Neutrality and Salt Hydrolysis, while some minor additions have also been made to the text. As before, general references are given to original authorities at the end of each chapter, and the book is such a good elementary text-book that those who are taking up the study of physical chemistry should not fail to get a copy; they will find that it well repays careful reading, both by the information it gives and the interest it awakens.

The World Machine. By Carl Snyder. London, New York, Bombay, and Calcutta: Longmans, Green, and Co. 1907.

The author of this book believes that possibly we have now at last come to know the cosmos as it is, regarding the universe as a cyclic process, or a ceaseless machine, without beginning or end. This marks a definite stage in men's knowledge, and calls for a historian to describe the method by which it has been attained, a task which has not yet been undertaken in that broad spirit which it demands. So, without going very deeply into the development of any branch of cosmic science, the author now sets before his readers an outlined but complete world-picture, discussing such items of knowledge as possess both finality and completeness, as distinguished from the so-called facts which lie in the debateable region, where gaps of ignorance have to be bridged by temporary hypotheses, which we know will ultimately fall, shattered by the weight of increasing knowledge. Thus the author in successive chapters describes how definite ideas were gradually reached concerning the shape of the earth, the fixity of the sun, and so forth to the last and still unanswerable riddle—gravitation—attaching to each advance the name of the moving spirit through whom it was achieved, and prefacing the whole with an interesting introduction on the overcoming of appearances and the beginnings of certitude. The author's style is particularly fanciful and imaginative, but he shows good judgment in discerning the true value of each man's work, a great merit in the writer of a history. In this book, which may be regarded as the first of a series of three, he contents himself with the recital of facts, hoping later in subsequent volumes to point the moral of the tale and discuss the mechanism of life.

The Gas Engineers' Pocket-book. By Henry O'Connor. Third Edition. London: Crosby Lockwood and Son. 1907.

This pocket-book contains tables and memoranda relating to the manufacture, distribution, and use of coal-gas, and to the construction of gas works, besides much miscellaneous information and general mathematical tables. One excellent feature is the abundance of graphic representations of numerical data, which are very convenient and clear, and gas engineers will find the book both comprehensive and concise, and, in fact, invaluable to them.

An Elementary Text-book of Metallurgy. By A. Humboldt Sexton, F.I.C., F.C.S. Fourth Edition. London: Charles Griffin and Co., Ltd. 1907.

The student who is beginning metallurgy will find in this book a course of elementary work which will exactly meet his needs. The treatment is sufficiently wide to enable him to get from it a general knowledge of metallurgy upon which to base the specialised study of the particular branch in which he is most interested, and at the same time it is by no means so slight as to be valueless. The appliances and materials employed in all common processes are first described, and the most important methods of extraction of, for instance, iron, copper, lead, &c., are then treated in detail, the chemistry of each process being very carefully explained, while plans showing the chief features of the more complicated extractions help to make them clear and to fix them on the memory. The alloys are included, and the applications of electricity to metallurgy are treated very shortly in one chapter. A course of practical work to illustrate the text is also outlined, and the book is in every respect very suitable for elementary students.

Utilisation of Nitrogen in Air by Plants. (II.). By Th. Jamieson. Aberdeen: Agricultural Research Association.

Undaunted by the reception accorded to his first work on this subject, a reception which, generally speaking, was far from favourable, the Director of the Aberdeen Agricultural Research Station, with laudable perseverance and belief in his discovery, has set about accumulating fresh evidence to confirm his theory of the direct utilisation of the nitrogen of the air by plants, and he has endeavoured to meet his opponents' genuine objections very fairly, while he has shown himself undisturbed by the animosity and even ridicule with which his criticisers have received his first announcement on the subject. He now describes quantitative experiments, and gives the details of series of tests, in which plants were grown under varying conditions and the nitrogen in them determined with every possible precaution. It was then always found that the nitrogen present in the plant after growth exceeded that provided (in the original plant and the materials used) by a considerable amount. Mr. Jamieson gives full information relating to the methods he adopted, and urges those interested to investigate the question for themselves, recommending the water fairy plant as suitable for the purpose. Clearly, the duty of repeating his experiments and detecting his error, if any, now rests with his opponents, who may not be disposed to accept his figures without confirmation, nor, we may add, be able to refute them without careful and accurate experimental work, such as Mr. Jamieson himself has evidently devoted to the study of this most important question.

Synopsis of Mineral Characters. By Ralph W. Richards. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1907.

In this book an alphabetical list is given of the commonest minerals, together with short statements of their distinguishing characteristics. Thus, crystalline form, cleavage, hardness, &c., are all enumerated, and the synopsis will make the identification of minerals in the field a matter of comparative simplicity. Some chemical properties are added, such as the phenomena exhibited before the blowpipe, and on heating in a closed tube, and also solubility in hydrochloric or other acid, and the author has taken pains to make the little book complete as far as it goes, although of course it will not take the place of a reference book on the identification of minerals.

MEETINGS FOR THE WEEK.

MONDAY, 29th.—Society of Arts, 8. (Cantor Lectures). "Detergents and Bleaching Agents used in Laundry Work," by Prof. Herbert Jackson, F.I.C., &c.

TUESDAY, 30th.—Royal Institution, 3. "Stimulation, Luminous and Chemical," by Prof. William Stirling, M.D., &c.

—— Society of Arts, 8. "Lustre Pottery," by William Burton.

WEDNESDAY, May 1st.—Society of Arts, 8. "The Defence of the Sea Coast from Erosion," by Alfred Edward Carey, M.Inst.C.E.

—— Royal Institution, 5. Annual Meeting.

THURSDAY, 2nd.—Royal Institution, 3. "The Bacchants of Euripides," by A. W. Verrall, Litt.D.

—— Society of Arts, 4.30. "The Applicability to India of Italian Methods of Utilising Silt." by Sir Edward C. Buck, K.C.S.I., &c.

—— Chemical, 8.30. "Chemical Action of Exradio—(1) Action on Distilled Water, (2) Action on Copper Salts in Solution," by Sir W. Ramsay. "Freezing-point Curves of the Menthyl Mandelates," by A. Findlay and E. M. Hickmans. "Constitution of Homo-eriodictyol, a Crystalline Substance from Eriodictyon Leaves," by F. B. Power and F. Tutin. "Relation between Valency and Heats of Combustion," by G. Le Bas.

FRIDAY, 3rd.—Royal Institution, 9. "Dexterity and the Bend Sinister," by Sir James Crichton-Browne, F.R.S.

SATURDAY, 4th.—Royal Institution, 3. "Scientific Work in the Sea Fisheries," by Prof. W. C. McIntosh.

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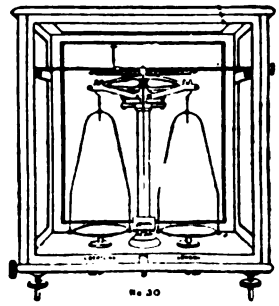

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ON THE PURIFICATION AND TESTING OF SELENION.*

By R. THRELFALL, F.R.S.

IN 1895 I was enabled by a Royal Society grant to obtain about 100 lbs. weight of selenion of about 99·5 per cent selenion content. The grant was applied for to enable me to extend to selenion the investigations already made on purified sulphur (Threlfall and Brearley, *Phil. Trans.*, A, 1896). For the purpose of the investigation it was necessary to purify the selenion beyond the standard usual for material to be used in atomic weight investigations. This proved in the event to be impossible on account of the comparatively slight volatility of selenion dioxide, and the impossibility of preventing its formation in the course of the electric measurements I proposed to carry out. Meanwhile, I had prepared a great deal of very pure selenion, and began to investigate its properties—other than those of conduction, for which absolute purity is essential (*Phil. Mag.*, Series 5, 1896, p. 42; *Phys. Review*, 1897, vols. iv. and v.).

The method of purification adopted was essentially that of Ekman and Petterson ("Uber das Atomgewicht des Selens," *Nova Acta der K. Soc. der Wissenschäften zu Upsala*, May 13, 1876, vol x., unpaged).

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3. Sublimation of selenious oxide.
4. Solution of the sublimate in water and filtration (to get rid of the very insoluble mercury selenite).
5. Precipitation of selenion by reduction with hydrochloric acid and sulphur dioxide.
6. Prolonged washing of the precipitated selenion.
7. Re-conversion of the selenion into selenious oxide and repeated sublimation in a current of air (to remove possible traces of tellurium).

In addition to a repetition of the above processes, I have investigated the analytical possibilities of the separation of tellurium from selenion, the application of the spectroscope to the testing of selenion for tellurium, the separation of the elements by sublimation of selenion dioxide, and examination of the product.

The first step was to investigate the original material for tellurium, and, if possible, to find a method of detecting that element in small quantities in presence of selenion. The best of the methods I tried was Oppenheim's (Crookes, "Select Methods of Chemical Analysis," 3rd edit., p. 422). By control experiments it was found that the limits of discrimination lay somewhere between one-tenth per cent and one-fortieth per cent of tellurium in the selenion—and this only when every precaution is taken. In some trials I used over 40 grms. weight of the original selenion in order to have the advantage of concentration of tellurium. The net result, however, was only to show that there was certainly less than one-tenth per cent Te, and probably less than one-fortieth per cent. I therefore, in the first instance, tried to obtain a spectroscopic method of detecting tellurium in presence of selenion, and for that purpose experimented with the electric arc, sparking between carbon terminals kept wet with solutions of tellurous acid and tellurium salts, Bunsen flames, &c., but in the end failed to find any line of sufficient persistence to be of service. By mixing 99 parts of very pure selenion with one part of tellurium, I failed to obtain any indication of tellurium, no matter what method I employed.

Attempts were made to separate the dioxides of selenion and tellurium by taking advantage of the great difference of solubility of the oxides; the results for small proportions of tellurium showed that a sharp separation could not be effected in this way.

Attempts to take advantage of the difference in the volatility of the oxides as practised by Ekman and Petterson were more favourable, and the results obtained indicated that a sharp separation could be made by one or at most two sublimations at 360° C.

The method was tested by mixing together 10·0098 grms. of selenion, not specially purified, and 0·09985 grm. of tellurium (bought as pure). This mixture was dissolved in nitric acid, evaporated to dryness as usual, and the residue collected and placed in a platinum boat in a wide glass tube. The tube was kept at a dull red heat, and a stream of dried and filtered air was passed slowly over it. The sublimate was then re-sublimed at from 290° to 320° C. to a spot further along the tube, and it was found that the re-sublimation of the first sublimate was complete, showing that nothing had been carried forward mechanically. During this process a trace of red selenion was formed—a thing which Ekman and Petterson have shown is not to be avoided, whatever care in eliminating dust may be taken. The second sublimate was dissolved in water, and the solution filtered (though it was practically clear), boiled with hydrochloric acid, saturated with sodium bisulphite, and left to stand for fifteen hours. The precipitated elements were washed, ground, and re-washed, and finally treated by the Oppenheim method of separation. This showed that no tellurium was present within the limits mentioned. The residue in the boat containing the metallic impurities was treated for the recovery of tellurium, and 0·0975 grm. of tellurium was recovered and weighed. The loss of tellurium from all causes in this rather complicated treatment was therefore 0·00233 grm. Taking everything into consideration this loss appeared to be within the limits of the experimental error. The important fact was that the oxide of selenion sublimed at the lowest visible red heat was totally re-sublimed at a temperature below 320° without any visible residue being left behind. So far as analysis can show, therefore, it appears that sublimation of the oxides affords a method of separation of the elements—though it cannot, of course, be a theoretically perfect method, for the oxide of tellurium must have some vapour pressure at 300° C.

Preparation of Purified Selenion.

Quantities of 335 grms. of bought selenion were treated in each operation.

The material, ground to a fairly fine powder and sieved, was dissolved in nitric acid, the acid removed, and the aqueous solution of selenious acid filtered. The filtrate was evaporated to dryness, and the oxide sublimed in dry and dust-free air at 360° C. To effect the sublimation, the oxide of selenion was introduced into a 3 cm. tube in a large platinum boat, and sublimation proceeded with till the tube got blocked up. The boat was then withdrawn, and the sublimate washed out of the tube by platinum distilled water. The air was filtered through long tubes containing cotton-wool, and dried, first by calcium chloride, and then by pure strong sulphuric acid. During the sublimation a certain amount of reduction always took place at first—while traces of water were being given off and an evil-smelling gas (H_2Se?) was evolved in small quantity. On re-subliming a portion of the sublimate, there was no further reduction or evolution of gas.

The sublimed selenium dioxide was dissolved to an almost absolutely clear and colourless solution in platinum distilled water, and this was then filtered and boiled with much water containing one-ninth of its volume of strong hydrochloric acid, and the selenion precipitated at the air

* A Paper read before the Royal Society, February 14, 1907.

temperature by sulphur dioxide which had passed through several wash-bottles and finally through a solution of silver nitrate. Sulphur dioxide was at first prepared from copper and sulphuric acid, and though there was no milkiness in the wash-bottles or darkening of the precipitated silver sulphite, it was feared that some sulphuretted hydrogen might possibly be formed, and therefore recourse was had, first to the production of the gas from sodium bisulphite, and finally to its production from the combustion of very pure sulphur. In the latter case rather elaborate arrangements were required. The sulphur was burned in a large sheet-iron cylindrical vessel, provided with a zinc tray containing the sulphur. The gases coming from the chamber passed in order through a glass tube 7 feet long; a plug of glass-wool, a Liebig's condenser, Woolfe's bottle containing distilled water, a plug of cotton-wool 2 inches long, a tube containing more cotton-wool and copper turnings; a tight plug of glass-wool (to filter off the dust from the cotton-wool if any was produced), and a long tube containing copper and silver-foil. The precipitation vessel was closed, and communicated with a suction pump, whereby the gases were drawn through the system. Most of the selenion prepared was precipitated by sulphur dioxide, prepared as described.

The operation of precipitating selenion is not complete for some time. The fine red powder of selenion (which is free from lumps or coagulated portions when the precipitation has been carried out without appreciable rise of temperature) was washed on a platinum-cone, and then exhibits many of the characteristics of a gelatinous substance; for instance, it could be got to vibrate when distorted, just like a jelly.

The washing is continued till some time after no trace of hydrochloric or sulphuric acid can be detected in the washings. The fine selenion is then coagulated to some extent by starting the filtering pump, which causes it to occupy a much reduced volume, and finally dried in a dish in a water-bath, when a great deal of water separates and the selenion coagulates and becomes dark in colour. No HCl or H_2SO_4 could be found in the water which separated.

The drying is continued till the mass can be broken up, when it is again heated in a water-oven, and finally placed in a vacuum desiccator.

When the selenion appeared to be dry, it was distilled in a current of air residue in a hard glass retort protected by a fire-clay and asbestos coating.

The air residue, consisting for the most part of nitrogen, was produced as described in a previous paper (*Phil. Mag.*, Series 5, January 1, 1893, vol. xxxv., p. 1).

In spite of all precautions, some oxide of selenion appeared in the receiver, and this was as far as possible caused to deposit on the top of the receiver by keeping the selenion hot, but of course there is no certainty that it was all concentrated there.

An attempt was made to get rid of SeO_2 by re-distilling the selenion from bulb to bulb *in vacuo* in a tube blown with three bulbs. The first bulb was charged with some of the distilled selenion which had come over first, the tube was pumped out by a Sprengel pump, and filled with the air residue, and was also provided with a piece of metallic magnesium at one end. The magnesium was heated both during pumping and later, when the tube was sealed off. The tube was heated while still in connection with the pump, and as the selenion melted it just gave enough gas to change the sound of the pump, but not enough to examine—it was estimated at less than one-twentieth of the volume of the selenion (say, one-tenth cc.). There was sufficient selenion dioxide driven off by heating the selenion to form a visible deposit on the next bulb of the tube. Now the heating may be considered to have taken place under conditions precluding the presence of any appreciable amount of oxygen in the high vacuum attained in presence of hot magnesium, so we must conclude that the selenion, as prepared in bulk, either contains some oxide, or oxidises during removal and storage at ordinary temperatures. Even if it had been practicable to heat all the selenion in a high vacuum, there is no evidence that all the oxide could be separated, and no test can be made to establish with certainty that oxide is absent, even after such treatment (see below). I was therefore obliged to abandon the scheme of treating selenion as a simple elemental body for conductivity experiments.

The selenion, prepared in the manner described above, was tested in the following way—it being recognised that both arsenic and mercury, besides unknown elements, might be present.

Samples of about 10 grms. weight were dissolved in strong nitric acid, the acid evaporated with constant additions of water on the water-bath, and the dry selenion dioxide dissolved in water. In all cases the nitric acid solution was absolutely clear and left no residue. The aqueous solution was just visibly opalescent, possibly through a slight reduction of the selenious acid by dust or owing to the presence of mercury selenite.

There appears to be some question as to the reliability of the modern methods of testing for arsenic in presence of selenium (Berry, *Journ. Chem. Soc. Ind.*, 1901, p. 322). After some preliminary trials, the following method was adopted:—

Ten grms. of selenium were converted into selenious acid and dissolved in water. The solution was mixed with a large excess of a solution of ferrous chloride, and distilled in presence of a stream of hydrochloric acid gas bubbled through the apparatus. Water was added till the distillate measured three times the volume of the original mixture put into the retort. The distillates were divided into four portions, of which the first and last were much smaller than the second and third. All distillates were saturated with H_2S with all precautions, and filtered. The precipitates (visible or invisible) were dissolved in small quantities of 20 per cent solution of pure sodium hydrate, acidified with sulphuric acid, boiled with potassium metabisulphite, and used in the electrolytic arsenic apparatus of Dr. Thorpe (*Trans. Chem. Soc.*, 1903, vol. lxxxiii., 969).

The first distillate was from the ferrous chloride and hydrochloric acid only, and showed no arsenic, the second and third gave arsenic mirrors, and the fourth no mirror.

The total arsenic collected amounted to 0·05 mgrm. As_2O_3 or 0·00038 per cent arsenic in the material tested.

Check experiments were made to test whether the selenion, in being reduced by the ferrous chloride and hydrochloric acid, prevents arsenic from distilling over, and whether the Thorpe apparatus gives a correct result for a solution of selenide of arsenic when treated as above. The result of these tests was to show that the ferrous chloride distilllation is effective in causing the arsenic to pass into the distillate, and that the arsenic is properly shown by the Thorpe apparatus. I have to thank Mr. T. H. Waller for suggesting the distillation with ferrous chloride and hydrochloric acid.

Testing for Mercury.—This is a matter of some difficulty, but the fact that an almost absolutely clear solution of selenious acid was obtained precludes the possibility of the presence of more than very minute quantities. Two methods of testing were employed.

In the first, 10 grms. of selenion were converted into sodium seleniate—or at all events selenious acid was neutralised with sodium hydrate and the product dried. The dry salt was then heated in a tube between plugs of glass-wool to a bright red heat in a current of purified and dried air just sufficient to ensure that anything capable of subliming should be carried into the cool part of the tube. The result was a large sublimate of selenious oxide. This sublimate was dissolved in water, saturated with excess of precipitated carbonate of calcium, dried on the water-bath, and re-heated in a hard glass tube, as before, first to a dull and afterwards to a bright red heat. The cold part of the tube contained a just visible sublimate. Mercury was tested for by Marcel's method (*Comptes Rendus*), using one strip of paper saturated with ammoniacal silver nitrate, and another saturated with hydrochloroplatinic acid. The paper

saturated with the silver compound did darken as the sublimate was chased up to it by a flame, but the appearance was not that produced by mercury, as shown in a check experiment; the platinum paper was not affected. This is a very sensitive test for mercury as claimed by Marcel.

The second investigation was kindly made for me by Dr. H. Sand, of Nottingham, by means of a rotating cathode which he has studied in regard to the separation of metals by electrolysis at carefully regulated voltages. About 11 grms. of the purified selenion were converted into selenious acid—acidified with nitric acid, and electrolysed under the conditions known to precipitate mercury from other salts—on to the rotating cathode. After an hour's work no deposit could be detected on the cathode, so it was made an anode in a small quantity of dilute nitric acid, and a current passed to a fine platinum-wire cathode. No mercury was deposited on the fine wire.

The sensitiveness of the method has not been communicated to me by Dr. Sand, but it probably is sensitive enough to show the presence of small quantities of mercury. We may conclude that either there is no mercury in the purified selenion, or if there is it is probably of the order of the arsenic content.

A sample of the selenion which had been used by Messrs. Mason and Vonwiller was returned to me for examination towards the end of 1906, and was examined by solution in nitric acid, &c. Nothing large enough to weigh could be extracted from 10 grm. samples, but there was, nevertheless, evidence that the selenion had picked up some impurities in the varied experiments which had been made upon it. Originally it was some of the purified and distilled product described above. There was a trace of organic matter separable from the nitric acid solution, and a few specks of insoluble white matter in the aqueous solution of selenious acid. There was also a trace of iron and alumina. The result of treating the filtrate from selenion precipitated by hydrochloric acid and sulphur dioxide with sulphuretted hydrogen was a minute dark coloured precipitate which was tested in the usual way, but could not, owing to its small quantity, be satisfactorily examined. Special tests for gold and platinum showed that it was not the latter, the former doubtful, and it did not appear to be mercury. Taking all the residues and precipitates together, the total weight could not have been more than 1 or 2 mgrms. My opinion is that the contamination consisted mainly of dust with a trace of mercury or gold, and some hydrocarbon—possibly oil or paraffin.

In letters of October 30 and November 19, Professor Pollock informs me that the selenion was, in fact, floated on mercury in some of the experiments and gilded in others, and the material had been re-melted at least a dozen times, so some contamination was to be expected. I made a special investigation for zinc, as Messrs. Mason and Vonwiller state that the selenion was melted in a zinc vessel, but the material was found absolutely free from this element, at all events to tests by potassium ferrocyanide and sodium sulphide, which are fairly delicate.

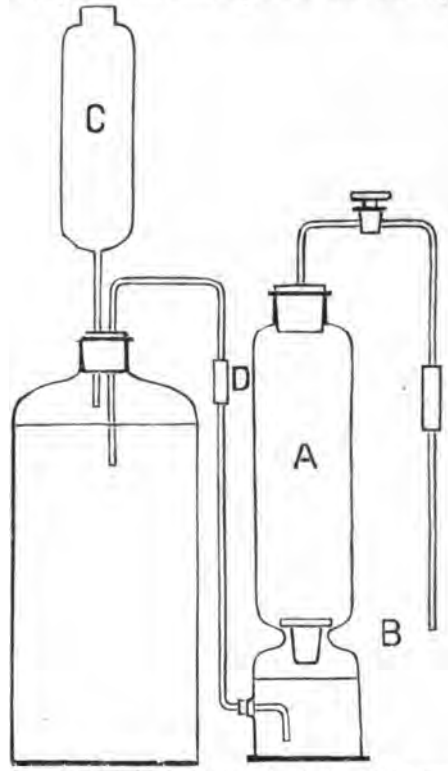
A test for SeO_2 was made in the following manner:—About 4 grms. of the selenion was placed in a hard glass tube 1 cm. diameter, drawn out to a long point—about 20 cm. long and 2 mm. diameter. The tube was connected with an apparatus for supplying hydrogen absolutely freed from oxygen, and was filled and pumped out many times. Finally, the pressure was reduced to about 30 mm. mercury, and sufficient hydrogen allowed to enter to insure that sublimates would be carried into the narrow part of the tube. A just visible sublimate of SeO_2 was observed. On repeating the trial with the same selenion to which 1 mgrm. of SeO_2 had been added; the sublimate was, at least, doubled, and, on adding 4 mgrms., a comparatively large sublimate was obtained, but it was almost instantly covered over by a deposit of selenion, or was reduced and thus removed. I think it is safe to conclude that 4 grms. of the selenion used by Vonwiller and Mason did not contain anything like 5 mgrms. of SeO_2, and probably only about 1 mgrm., but the test is not entirely satisfactory.

My thanks are due to Dr. George Elliot, of Sydney, for his kindness in supplying me with considerable quantities of specially purified acids.

AN IMPROVED GAS GENERATOR.

By F. SOUTHERDEN, B.Sc., F.I.C.

THE general construction of this apparatus is apparent from the figure. A is a "lime tower," about 12 inches in height, the upper portion of which is packed with the solid reagent, a flat stopper with the top partially chipped away, fitting quite loosely at B. The liquid reagent is contained in a "Winchester quart" bottle connected to A by a syphon tube; and since this tube does not reach far below the surface, fresh liquid always syphons into A, the denser spent liquor sinking, as returned, towards the bottom of the reservoir. The stem of the funnel, C, reaches to such a point that, as the liquid sinks in the lower bulb of A, the corresponding rise of level in the reservoir causes liquid to enter the funnel, so that if through vigorous action the syphon empties, it automatically re-fills when next required.



Should the tap be left turned on, only the liquid in A becomes exhausted, and to re-start it is merely necessary first to slope the whole apparatus, so that most of the liquid syphons back from A into the reservoir. A rubber tube at D renders the connection between the vessels more flexible, and by arranging it above the level in the bottle all possibility of mess, consequent on leakage, is avoided.

The apparatus has proved specially useful where a moderate supply of gas is very frequently required, *e.g.*, as a generator of sulphuretted hydrogen. Though less portable than the ordinary Kipp's apparatus, it requires much less attention on account of the very large acid reservoir, and the replenishing of acid or sulphide is more conveniently and rapidly carried out.

Royal Albert Memorial College, Exeter.

FOURTEENTH ANNUAL REPORT OF THE COMMITTEE ON ATOMIC WEIGHTS.

DETERMINATIONS PUBLISHED DURING 1906.*

By F. W. CLARKE.

During 1906 there was a remarkable activity among the workers upon atomic weights, and many new determinations were published. Brief summaries of the new data are given in the following pages.

Nitrogen.

Three papers on the atomic weight of nitrogen have appeared during 1906, but they are essentially critical and contain no new determinations. First, Guye has summed up all the recent work upon this constant, and shown that it cannot vary much from 14·01 (*Ber.*, xxxix., 1470). Gray (*Journ. Chem. Soc.*, lxxxix., 1173) has subjected Stas' determinations to a searching criticism, and attempted to discover their possible source of error. Various alternatives are suggested, but no definite conclusion is reached. Scott (*Proc. Chem. Soc.*, xxi., 300) has re-discussed his old analyses of ammonium chloride and bromide (*Journ. Chem. Soc.*, lxxix., 147), which were discordant, and finds that upon applying the new value for chlorine to them (Cl = 35·473) the disagreement vanishes. On this basis his figures give, from NH_4Br, N = 14·010, and from NH_4Cl, N = 14·013. These figures are in harmony with the modern physico-chemical determinations.

Silver.

The accepted value for the atomic weight of silver rests upon analyses of chlorates, bromates, and iodates, and upon the ratios between the figures thus obtained for the halides and the ratios of the latter to silver. The chief pair of ratios is that of $KClO_3$: KCl and KCl : Ag, from which, when O = 16, Ag = 107·927.

The potassium chlorate ratio has now been re-investigated by Guye and Ter Gazarian (*Comptes Rendus*, cxliii., 411), who find that the crystallised salt contains a constant impurity of KCl, amounting to 2·7 parts in 10,000. This contamination was overlooked by Stas, and when it is taken into account the atomic weight of silver is reduced to 107·879.

With this datum, the modern atomic weights for nitrogen and carbon, and Dixon and Edgar's value for chlorine, the authors have re-computed the atomic weight of silver from data already existing. The results of the re-calculation are as follows:—

Ag : $AgNO_3$	Ag = 107·882
Ag : $AgC_2H_3O_2$	107·886
Ag : $AgC_7H_6O_2$	107·888
Ag : NH_4Cl	107·871
Ag : Cl	107·895
N_2O_5 : Cs_2O and Ag : CsCl	107·885
N_2O_5 : K_2O and Ag : KCl	107·901
$KClO_3$: KCl and Ag : KCl	107·879
$AgClO_3$: AgCl and Cl : H	107·908
$AgClO_3$: AgCl and Ag : AgCl ..	107·905
Mean	107·890

The concordance of these values is most striking, and the argument for a lower atomic weight for silver is very strong.

In another paper, discussing some of the same evidence, Guye (*Journ. Chim. Phys.*, iv., 174) has pointed out the necessity for a general revision of the atomic weights upon the basis of modern physico-chemical data. He also calls attention to the remarkable experiments of Landolt and others on apparent changes of weight during chemical reactions, and shows that in any general discussion of atomic weights, investigations of that order should be taken into account.

Chlorine.

Guye and Ter Gazarian (*Comptes Rendus*, cxliii., 1233) have determined the density of HCl. At 0°, 760 mm., sea level, and lat. 45°, one litre of the gas weighs, in grms.—

	1·6404
	1·6397
	1·6389
	1·6401
Mean	1·6398

Reducing this value by means of the critical constants, the authors find Cl = 35·461. This agrees closely with the gravimetric determination of Dixon and Edgar.

Bromine.

The atomic weight of bromine, referred to Ag = 107·93 and Cl = 35·473, has been carefully re-determined by Baxter (*Journ. Am. Chem. Soc.*, xxviii., 1322). First, the ratio Ag : AgBr was measured. The data are given below, with weights reduced to a vacuum.

Weight Ag.	Weight AgBr.	Atomic weight Br.
4·71853	8·21363	79·946
5·01725	8·73393	79·952
5·96818	10·38932	79·953
5·62992	9·80039	79·951
8·13612	14·16334	79·954
5·07238	8·82997	79·954
4·80711	8·36827	79·956
4·27279	7·43776	79·947
5·86115	10·20299	79·953
7·91425	13·77736	79·958
6·40765	11·15468	79·959
6·38180	11·10930	79·952
6·23696	10·85722	79·953
9·18778	15·99392	79·953
8·01216	13·94826	79·953
10·48638	18·25452	79·953
8·59260	14·95797	79·954
8·97307	15·62022	79·953
	Mean	79·953

Secondly, silver bromide was transformed into chloride by heating in a current of chlorine. The corrected data are as follows:—

Weight AgBr.	Weight AgCl.	Atomic weight Br.
8·03979	6·13642	79·953
8·57738	6·54677	79·952
13·15698	10·04221	79·952
12·71403	9·70413	79·952
13·96784	10·66116	79·951
13·08168	9·98469	79·953
12·52604	9·56059	79·953
11·11984	8·48733	79·952
8·82272	6·73402	79·953
11·93192	9·10721	79·951
12·53547	9·56767	79·955
17·15021	13·09009	79·952
10·31852	7·87572	79·952
	Mean	79·952

The value Br = 79·953 is the one finally adopted.

Iodine.

The electro-chemical equivalent of iodine has been measured by Gallo (*Gazz. Chim. Ital.*, xxxvi., 116). Iodine was liberated electrolytically from a solution of potassium iodide, and determined by titration with sodium thiosulphate. In the same circuit silver was deposited in a silver voltameter. The equivalent weights, reduced to a

* From the *Journal of the American Chemical Society*, xxix., No. 3.

vacuum, and with values for I referred to Ag = 107·93, are given below.

Weight Ag.	Weight I.	Atomic weight I.
0·18054	0·21230	126·92
0·21360	0·251309	126·98
0·23103	0·27181	126·90
0·24005	0·28213	126·85
0·18167	0·18167	126·85
0·2597	0·30515	126·82
0·16229	0·19080	126·89
0·300988	0·35411	126·98
0·26819	0·31528	126·88
0·25877	0·30425	126·90
0·24422	0·28703	126·85
0·20838	0·24516	126·92
0·25047	0·29445	126·88
0·20266	0·23826	126·89
0·18316	0·21533	126·89
0·27278	0·43809	126·84
0·28221	0·33207	126·90
0·2582	0·30356	126·89
0·33963	0·39923	126·88
0·33461	0·39345	126·91
0·3360	0·39502	126·89
0·37025	0·43526	126·88
0·30824	0·36233	126·87
0·36390	0·42789	126·91
	Mean	126·89

The values found are not very concordant, and the determination can hardly be given much weight when compared with the recent measurements by Baxter.

Potassium.

The ratios connecting potassium chloride with silver and silver chloride have been re-determined by Richards and Staehler (*Ber.*, xxxix., 3611). The data are as follows, with vacuum weights:—

First, Ag : KCl :: 1 : x.

Weight KCl.	Weight Ag.	Ratio.
2·35178	3·40295	0·681100
1·97348	2·85582	0·691038
3·88074	5·61536	0·691094
7·44388	10·77156	0·691068
5·00681	7·24514	0·691058
5·04833	7·30515	0·691065
8·19225	11·85412	0·691089
4·99795	7·23230	0·691060
5·16262	7·47042	0·691075
	Mean	0·691072

Hence, if Ag = 107·93 and Cl = 35·473, K = 39·114.

The first two experiments are regarded as preliminary.

Second, AgCl : KCl :: 1 : x.

Weight KCl.	Weight AgCl.	Ratio.
(*a*) 3·88672	7·47271	0·520122
(*a*) 3·47292	6·67680	0·520147
(*a*) 8·75449	16·83071	0·520150
4·36825	8·39858	0·520118
5·56737	10·70384	0·520128
6·41424	12·33228	0·520120
3·27215	6·29126	0·520110
4·83028	9·28702	0·520111
	Mean of last five	0·520118

(*a*) Preliminary determinations, not included in the mean.

Hence, K = 39·114.

Sodium.

Incidentally to a paper upon the transition temperature of sodium bromide, Richards and Wells (*Proc. Amer. Acad.*, xli., 443) give two determinations of the ratio AgBr : NaBr :: 1 : x. The data with vacuum weights are—

Weight NaBr.	Weight AgBr.	Ratio.
5·49797	10·03253	0·54814
3·64559	6·65248	0·54805

If Ag = 107·93 and Br = 79·955, Na = 23·008—a value in agreement with that previously found from analyses of sodium chloride.

Manganese.

Baxter and Hines (*Journ. Am. Chem. Soc.*, xxviii., 1560) have revised the atomic weight of manganese through analyses of the chloride and bromide. The data with reference to the chloride are as follows:—

Weight $MnCl_2$.	Weight AgCl.	Weight Ag.	Atomic weight Mn. AgCl ratio.	Atomic weight Mn. Ag ratio.
4·62970	10·54641	7·93740	54·957	54·960
3·52899	8·03868	6·05041	54·962	54·958
3·30881	7·53731	5·67279	54·959	54·960
3·56843	8·12932	6·11818	54·950	54·955
3·45083	7·86129	5·91637	54·952	54·958
4·47948	10·20372	7·67995	54·963	54·959
3·92089	8·93140	6·72227	54·962	54·958
		Mean	54·958	54·958

All weights are reduced to a vacuum, and computations were based upon Ag = 107·93 and Cl = 35·473. The bromide series gave the following results when Br = 79·953:—

Weight $MnBr_2$.	Weight AgBr.	Weight Ag.	Atomic weight Mn. AgBr ratio.	Atomic weight Mn. Ag ratio.
5·58416	9·76561	—	54·964	—
5·63432	9·85345	—	54·961	—
6·53738	11·43300	6·56755	54·957	54·962
4·81005	8·41206	4·83238	54·959	54·957
4·88097	8·53642	4·90354	54·950	54·960
5·63219	9·85008	5·65813	54·954	54·964
6·52626	11·41293	—	54·968	—
5·79924	10·14206	5·82600	54·957	54·963
3·59809	6·29271	3·61478	54·952	54·957
5·16334	9·02959	5·18711	54·966	54·965
3·92226	6·85968	3·94042	54·951	54·959
4·49158	7·85571	4·51250	54·942	54·953
3·60071	6·29740	3·61736	54·949	54·960
4·77392	8·34915	4·79620	54·951	54·951
3·57660	6·25569	3·59319	*54·933	54·957
5·69972	9·96840	5·72641	54·947	54·948
6·58983	—	6·62041	—	54·957
4·19911	—	4·21839	—	54·967
Mean, rejecting the starred value ..			54·955	54·959
Mean of both series			54·957	

Cobalt.

The determinations by Baxter and Coffin of the atomic weight of cobalt are based upon analyses of the chloride (*Journ. Am. Chem. Soc.*, xxviii., 1560). The data are subjoined, with corrected weights, and reduced with Ag = 107·93 and Cl = 35·473.

Weight $CoCl_2$.	Weight AgCl.	Weight Ag.	Atomic weight Co. AgCl ratio	Atomic weight Co. Ag ratio.
1·09959	2·42676	1·82671	59·009	58·991
1·47733	3·26095	2·45398	58·988	59·005
3·84133	8·47735	6·38081	59·014	59·005
2·96315	6·54019	4·92244	58·997	58·995
3·48418	7·69084	5·78815	58·986	58·991
3·29523	7·27284	5·47410	59·002	58·995
1·57655	3·48012	2·61905	58·982	58·992
3·64342	—	6·05232	—	58·999
		Mean	58·997	58·997

Hence Co varies from the round number 59 only within the limits of experimental uncertainty.

(To be continued).

DECOMPOSITION OF CHLORAL HYDRATE BY CAUSTIC SODA.

By FRANK E. WESTON, B.Sc., and HENRY R. ELLIS, B.Sc.

HAVING observed discrepancies in the estimation of chloral hydrate by caustic soda, the following investigation was carried out to determine when the equation $CCl_3CH(OH)_2 + NaOH = CHCl_3 + HCOONa$ is true.

In certain text-books (Perkin and Kipping) this equation is given to represent the action of boiling alkalis on chloral hydrate; this statement is erroneous, the reaction under these conditions consisting of two distinct reactions:—

$$CCl_3CH(OH)_2 + NaOH = CHCl_3 + HCOONa + H_2O \quad . \; . \; 1.$$

$$CHCl_3 + 4NaOH = 3NaCl + HCOONa + 4H_2O \quad . \; . \; 2.$$

The second reaction is not complete, owing to the volatility of the $CHCl_3$; if this body is not allowed to escape, the equation representing the total change may be given as $CCl_3CH(OH)_2 + 5NaOH = 2HCOONa + 5H_2O + 3NaCl$.

The chloroform is decomposed at temperatures from 40° C. upwards, and this causes low results when the liberated $CHCl_3$ is estimated by passing it over red-hot lime in the usual manner ("Mann's Forensic Medicine and Toxicology"). If the chloral hydrate is estimated by NaOH, the results are too high unless low temperatures are used.

When the chloral was decomposed by Na_2CO_3 the decomposition of the liberated $CHCl_3$ was much less.

The NaOH used was obtained from metallic sodium (the Na was exposed to a moist atmosphere free from CO_2) and was quite free from chlorides.

The chloral hydrate used was supplied by Kahlbaum, and the solution used contained 30 grms. per litre.

Constant Temperature (18° C.), Times varying.

	Time. Minutes.	Chloral hydrate. Cc.	N. NaOH. Cc.	N. H_2SO_4. Cc.	Mean. Cc.	NaOH used. Cc.
1.	2	20	25	21·4	21·4	3·6
	2	20	25	21·4		
	(a) 2	20	25	21·4		
2.	5	20	25	21·3	21·29	3·71
	5	20	25	21·3		
	(a) 5	20	25	21·275		
3.	10	20	25	21·075	21·1	3·9
	10	20	25	21·075		
	(a) 10	20	25	21·15		
4.	20	20	25	21·125	22·075	3·925
	20	20	25	21·075		
	(a) 20	20	25	21·025		
5.	40	20	25	21	21·00	4·0
	40	20	25	21		
	(a) 40	20	25	21·025		
6.	80	20	25	20·975	20·94	4·06
	80	20	25	20·925		
	(a) 80	20	25	20·925		
7.	200	20	25	20·55	20·44	4·56
	200	20	25	20·44		
	(a) 200	20	25	20·325		
8.	2000	20	25	19·35	19·3	5·7
	2000	20	25	19·25		
	(a) 2000	20	25	19·3		
9.	7200	20	25	16·525	16·54	8·46
	7200	20	25	16·525		
	(a) 7200	20	25	16·675		

(a) The $CHCl_3$ not shaken out of the solution.

Conclusions.

1. The caustic soda present very slowly attacks the chloroform, which is liberated from the chloral hydrate with the formation of sodium formate and sodium chloride.

2. It is unnecessary to shake the solution until the turbidity disappears.

3. If the reaction takes place in the cold, it proceeds in accordance with the usual equation:—

$$CCl_3CH(OH)_2 + NaOH = CHCl_3 + H.COONa + H_2O.$$

The decomposition of the $CHCl_3$ then proceeds so slowly that it exerts little influence on the result until some time has elapsed.

Experiments at Varying Temperatures.

The NaOH solution was heated to the desired temperature on a water-bath and the chloral hydrate solution run in quickly; as soon as the turbidity disappeared the remaining caustic soda estimated (after cooling quickly) by N. H_2SO_4, and the chloride by N/10 $AgNO_3$.

	Temp.	Chloral hydrate.	N. NaOH.	Means of several titrations. N. H_2SO_4.	N. NaOH used.	N/10 $AgNO_3$.
	°C.	Cc.	Cc.	Cc.	Cc.	Cc.
1.	0	20	25	21·6	3·5	—
2.	15	20	25	21·4	3·6	—
3.	20	20	25	21·4	3·6	—
				21·4	3·6	—
4.	40	20	25	20·625	4·375	—
				20·6	4·4	—
5.	50	20	25	20·6	4·4	2·94
				20·6	4·4	2·96
6.	70	20	25	18·2	6·8	20·7
				18·2	6·8	20·7
7.	80	20	25	17·3	7·7	32·25
8.	90	20	25	14·5	10·5	59·825
9.	100	20	25	13·425	11·575	66·5
				14·525	10·5	57·95
				11·75	13·25	79·575

Results.

The NaOH attacks the $CHCl_3$ liberated, the amount of $CHCl_3$ transformed below 50° C. being small.

The $CHCl_3$ seems to be decomposed in accordance with the equation $CHCl_3 + 4NaOH = HCOONa + 3H_2O + 3NaCl$. A formate was found in the residue after boiling $CHCl_3$ with NaOH for a short time.

Caustic Soda run into Warm Solution of Chloral Hydrate Solution at Varying Temperatures.

The flask was shaken until turbidity disappeared, cooled, and the excess of alkali determined by N. H_2SO_4, and the sodium chloride by N/10 $AgNO_3$.

	Temp.	Chloral hydrate.	N. NaOH.	Mean of several titrations. N. H_2SO_4.	N. NaOH used.	N/10 $AgNO_3$.
	°C.	Cc.	Cc.	Cc.	Cc.	Cc.
1.	40	20	25	20·025	—	—
				20·05	—	—
2.	50	20	25	20·55	4·45	2·425
				20·6	4·4	2·525
3.	70	20	25	19·725	5·275	13·675
4.	80	20	25	18·925	6·075	18·45
5.	90	20	25	16·15	8·85	45·05
6.	100	20	35	18·85	6·15	23·6

Conclusions.

The chloral is volatile in steam, hence these readings are all much less than the others obtained when chloral was run into warm caustic soda solutions.

Reaction between Boiling NaOH *and Chloral Hydrate.*

	Chloral (cc.).	N. NaOH (cc.).	N. H_2SO_4 (cc.).	NaOH used (cc.).	N/10 $AgNO_3$ (cc.)
Experiment 1.—Chloral hydrate dropped from burette to boiling NaOH in open flask, cooled as soon as the amount required had been added, and at once titrated against H_2SO_4	20	25	14·85	10·15 (6·65)	52
Experiment 2.—Same as No. 1, chloral hydrate added more slowly	20	25	12·1	12·9 (9·4)	78·2
Experiment 3.—The two solutions mixed cold and boiled together for one hour	20	25	11·45	13·55 (10·05)	78·8
	20	25	10·6	14·4 (11·9)	86·2
Experiment 4.—The chloral hydrate solution dropped slowly through a reflux condenser to the boiling caustic soda and boiled for one hour	20	25	14·2	10·8 (7·3)	59·6
	20	25	13·1	11·9 (8·4)	58·35
Experiment 5.—The chloral hydrate added slowly to the bottom of the boiling alkali solution and boiled ander a reflux condenser for a short time	20	25	11·45	13·55 (10·05)	79·275
	20	25	10·95	14·55 (11·05)	86·475

Results.

The decomposition took place more rapidly in the last experiments; since the $CHCl_3$ was liberated under the NaOH it had less chance of escaping.

By subtracting 3·5 cc. from the readings in the fourth column the number obtained is the volume of NaOH used to decompose the liberated chloroform. (These numbers are inserted in parentheses under the numbers in column 4).

The ratio between the number of cc. of N. NaOH and N. $AgNO_3$ required for each 20 cc. of chloral approximates in each case to 4 : 3, clearly showing that the $CHCl_3$ decomposes in accordance with the equation $CHCl_3 + 4NaOH = 3NaCl + HCOONa + 3H_2O$.

Similar experiments with $CHCl_3$ alone gave results in agreement with this equation.

The presence of the formate did not affect the estimation of the chloride. A solution of N/10 NaCl, containing about 8 grms. of sodium formate per litre, was estimated by means of the N/10 $AgNO_3$; in no case was any error caused by the formate.

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Preparation of Argon from the Air by means of Calcium Carbide.—Franz Fischer.—In order to prepare pure argon the author used a mixture of calcium carbide containing 10 per cent of calcium chloride. This absorbs nitrogen very readily at 800°, while pure carbide scarcely reacts at all at that temperature. The oxygen of the air is also absorbed by the mixture, calcium oxide and carbon being formed, and thus argon is left. The mixture is heated to 800° in strong-walled iron tubes in an ordinary gas furnace *in vacuo*. Gases are first evolved, among them acetylene, formed by the action of small quantities of water vapour given up by the calcium chloride, upon the carbide. Tarry products also distil over. When the evolution of gases ceases, dry pure air is allowed to pass in, and everything is then absorbed except argon and the other inert gases. The other products of the reaction are carbon, calcium oxide, and cyanamide.—*Berichte*, vol. xl., No. 5.

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

PART II.—ANALYSIS OF THE SILVER, COPPER, AND TIN GROUPS.

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 201).

PROCEDURES AND NOTES (*continued*).

Precipitation and Separation of the Copper and Tin Groups.

Procedure 21.—Treat separately as follows the various acid solutions previously obtained (P. 11, 4, 2, 5, 6, 7, 8), each of which should contain 4 cc. HCl (1·12) or 1·5 cc. H_2SO_4 (1·84), and have a volume of about 40 cc. Heat the solution in a conical flask nearly to boiling, and pass into it H_2S gas until it is saturated, and then for ten to fifteen minutes longer, keeping the solution at 70—90°. [*If the rarer elements are likely to be present, continue the precipitation in a pressure bottle as described in N. 3]. Cool the mixture; without filtering add to it 60 cc. water, completely saturate it in the cold with H_2S gas, cork the flask, shake it, and allow it to stand fifteen minutes. Filter, and wash the precipitate with hot water. (Precipitate, P. 22; filtrate, P. 61).

Notes.

1. No sharp line can be drawn between the solubilities of the sulphides of the copper and tin groups and those of the iron group; they form rather a graded series in which the solubility of each member differs from that of the next only by a greater or less amount. Since now, owing to the effect of the added acid in reducing the ionisation of the hydrogen sulphide, the solubility of any sulphide increases as the concentration of acid (or, more strictly, of hydrogen ion) in the solution increases, the line between precipitation and non-precipitation will fall at a point in the series dependent on the acid concentration and temperature. Thus, if arranged in the order in which they are precipitated from cold HCl solutions of decreasing concentration, the series is approximately as follows:—Arsenic, mercury and copper, antimony, bismuth and stannic tin, cadmium, lead and stannous tin, zinc, iron, nickel and cobalt, manganese. For reasons connected with the analysis of the separate groups, and for the reason that the separation is then a fairly sharp one, it has been found best to adjust the acid concentration so as to cause lead and stannous tin to precipitate and zinc to remain in solution.

2. The effect of acid on the precipitation of the various sulphides is explained by the Mass Action Law and Ionic Theory as follows:—When a dilute solution, whether aqueous or acid, is saturated at a definite temperature with H_2S gas under the atmospheric (or any definite pressure) the H_2S as such always has the same concentration. This ionises, however, to a slight extent into $H+$ and $HS-$, and to a still less extent into $2H+$ and $S=$. It is only the latter form of ionisation that needs to be considered here. Now between the H_2S and its ions must be maintained the equilibrium expressed by the equation $(C_{H+})^2 \times C_{S=} = \text{const.} \times C_{H_2S}$; or, since in this case C_{H_2S} = const., as just stated, it follows that also $(C_{H+})^2 \times C_{S=} = \text{const.}$ From this it is evident that when C_{H+} is increased by the addition of acid to the solution, $C_{S=}$ must be decreased in the proportion in which the square of C_{H+} is increased; thus, if C_{H+} is doubled, $C_{S=}$ will be reduced to one-fourth. But in order that a sulphide —for example, of the formula $M++S=$ — may precipitate, the concentration product $C_{M++} \times C_{S=}$ must attain a value equal to the solubility product, which is the value of this concentration product which prevails in pure water in contact with the solid sulphide. The solubility product varies, however, with the nature of the

* From the *Technology Quarterly*, xix., No. 3 September, 1906.

sulphide and with the temperature; and therefore the acid concentration that will barely permit of precipitation when C_{M++} has a definite value (for example, 1 mgrm. in 100 cc.) will be different for different sulphides and for the same sulphide at different temperatures. This acid concentration also varies with the nature of the acid, since the various acids are ionised to a different extent; thus, zinc is precipitated from a fairly concentrated solution of acetic acid, since, owing to the slight ionisation of this acid, the H+ concentration is less than in a far more dilute solution of hydrochloric acid.

3. The solution is first saturated with H_2S at nearly the boiling temperature, because certain elements, especially arsenic in the higher state of oxidation (and the rarer elements, platinum and molybdenum), are only slowly and incompletely precipitated in the cold, and because the precipitates of almost all sulphides separate from hot solutions in a form better suited for filtration. In case precipitation seems to continue after the solution has become fully saturated with H_2S, it indicates that one of the elements just named may be present; and, to insure complete precipitation of the arsenic, the heating and passage of the gas must sometimes be continued for an hour longer. [*In the case of molybdenum and the platinum elements, it is necessary, after most of the sulphide has separated, to cool the solution, to saturate it in the cold with H_2S in a stout bottle, to stopper the bottle with a cork securely held in place by wire, and to heat the bottle in a vessel of boiling water for an hour]. The solution is at first diluted to only about 40 cc., because arsenic is more rapidly thrown out from rather strongly acid solutions, and because titanium would be precipitated as hydroxide if the solution were further diluted and were kept near the boiling temperature; moreover, bismuth and a moderate quantity of antimony do not precipitate as oxychloride at this dilution, but might do so if the solution were at once further diluted. The solution is finally diluted to 100 cc., completely saturated in the cold, and allowed to stand, in order to cause the precipitation of even 1 mgrm. of cadmium, lead, or stannous tin. Zinc, iron, nickel, and cobalt, on the other hand, do not precipitate at all under these conditions, even when 500 mgrms. are present alone; and even 1 or 2 mgrms. of any of them can be detected in the filtrate when large quantities of elements of the copper and tin groups are also present.

4. If at first a white or yellowish precipitate forms which immediately turns black with more H_2S it indicates mercury. The white compound is $HgCl_2.2HgS$, and this is converted into HgS by the excess of H_2S. An orange precipitate separating from the hot, more concentrated solution shows antimony, or much cadmium (or selenium); a yellow one, arsenic or stannic tin. A yellow precipitate separating from the cold more dilute solution shows cadmium. All the other sulphides are black or brownish black. For the composition of the H_2S precipitates, see Table V. The quantity of sulphur combined with the metallic element, however, varies with the conditions of precipitation, owing to partial reduction, in the cases of arsen*ic* arsenic and antimonic antimony [*and of gold, selenium, tellurium, and probably molybdenum]. The extent to which the sulphides are combined with water and with hydrogen sulphide is also variable, and, in general, unknown.

5. A white, finely divided precipitate of free sulphur will be formed if the solution contains substances capable of oxidising H_2S. The most important of these likely to be present are ferric salts, chromates, [*vanadates], permanganates, and chlorates. Nitric acid, if moderately concentrated, would also destroy the H_2S; and for this reason it must have been removed as directed in P. 4. The reduction by H_2S of ferric salts to ferrous is attended by a change in colour from yellow to colourless; of chromates to chromic salts, from orange to green; [*of vanadates to vanadyl salts, from yellow to blue]; and of permanganates to manganous salts, from purple to colourless.

Procedure 22.—Transfer the H_2S precipitate (P. 21) to a small casserole, add to it 10 to 25 cc. ammonium monosulphide (if the original substance was treated with HNO_3 in P. 3), or 5 to 10 cc. ammonium polysulphide (if it was dissolved in water alone), cover the dish, and warm the mixture slightly (to 40—60°) for about ten minutes with frequent stirring. Add 10 cc. water, filter, and wash once with hot water. [If the residue is considerable in amount and much has been extracted from it by this treatment, as indicated by its appearance, or as determined in P. 41, warm it again with ammonium monosulphide or polysulphide, and filter, collecting the filtrate separate from the first one]. Wash the residue thoroughly with hot water, to which, in case the precipitate tends to pass through the filter, about 5 per cent solid NH_4NO_3 should be added. (Residue, P. 23; solutions, P. 41).

Notes.

1. In separating the copper and tin groups it is better to use (colourless) ammonium monosulphide rather than (yellow) polysulphide whenever the H_2S precipitate must contain any tin and most of any antimony present in the state of the higher sulphide (SnS_2 or Sb_2S_5). This is the case when hot concentrated nitric acid was used originally in dissolving the substance, but may not be so when water alone (or HCl) was used; hence the directions as to the choice between the two solvents. The polysulphide has the disadvantage that it dissolves a not inconsiderable quantity of CuS and HgS, thus making the tests for copper and mercury less delicate, and making it more difficult to determine from the colour of the HCl precipitate obtained from the ammonium sulphide solution in P. 41 whether or not elements of the tin group are present. The polysulphide must, nevertheless, be used if tin may be present as SnS, or much antimony as Sb_2S_3; for in the monosulphide SnS is almost insoluble and Sb_2S_3 is only moderately soluble (50 to 100 mgrms. Sb in 10 cc. of the reagent).

2. In order that the separation of the copper and tin groups by ammonium sulphide may be as complete as possible, it is necessary to employ a concentrated reagent highly charged with hydrogen sulphide, and containing, in the case of the polysulphide, an appropriate excess of sulphur. Suitable reagents are prepared by completely saturating a measured volume of NH_4OH of specific gravity 0·90 with H_2S in the cold, adding a fresh portion of NH_4OH (0·90) equal to two-thirds of the original volume, and diluting the mixture with an equal volume of water. From this solution, which constitutes "ammonium monosulphide," the "ammonium polysulphide" is prepared by dissolving in 1 litre of it 25 grms. of flowers of sulphur. These reagents, especially the monosulphide, should be kept as far as possible out of contact with the air, which is conveniently done by storing them in small, completely filled, glass-stoppered bottles, for the oxygen of the air destroys the sulphide with liberation of sulphur, which at first combines with the still unchanged sulphide, but precipitates later when the oxidation becomes more complete. The monosulphide reagent is a solution of $(NH_4)_2S$, and of the products of its hydrolysis, NH_4SH, NH_4OH, and a little H_2S. The polysulphide contains in addition various polysulphides of the forms $(NH_4)_2S_{2-5}$ and $(NH_4)HS_{2-5}$ in unknown proportions.

3. The action of ammonium sulphide in dissolving the sulphides of the tin group depends on the formation of soluble salts of sulphoacids with complex anions. When the monosulphide is used the reactions are as follows:—

$$\left\{\begin{matrix}As_2S_3\\Sb_2S_3\end{matrix}\right\} + 3(NH_4)_2S = 2\left\{\begin{matrix}(NH_4^+)_3AsS_3^{\equiv}\\(NH_4^+)_3SbS_3^{\equiv}\end{matrix}\right\}$$

$$\left\{\begin{matrix}As_2S_5\\Sb_2S_5\end{matrix}\right\} + 3(NH_4)_2S = 2\left\{\begin{matrix}(NH_4^+)_3AsS_4^{\equiv}\\(NH_4^+)_3SbS_4^{\equiv}\end{matrix}\right\}$$

$$SnS_2 + (NH_4)_2S = (NH_4^+)_2SnS_3^{=}$$

The excess of sulphur in the polysulphide oxidises the lower sulphides (As_2S_3, Sb_2S_3, SnS) to the same sulpho-salts as are obtained by dissolving the higher sulphides (As_2S_5, Sb_2S_5, SnS_2) in ammonium monosulphide. It will be seen that these sulpho-salts are analogous to the salts of the familiar oxygen acids of these elements, the difference being that sulphur has replaced oxygen. *Analogous sulpho-salts are formed with platinum, gold, and molybdenum, such as $(NH_4)_2PtS_3$, $(NH_4)_3AuS_3$, and $(NH_4)_2MoS_4$. Tellurium and selenium probably form similar compounds; but they may also combine directly with the ammonium sulphide in the same way as sulphur does, forming such compounds as $(NH_4)_2SSe_x$.

4. When ammonium monosulphide is used 500 mgrms. of any of the comman tin-group elements, in the form of higher sulphide, dissolve in 25 cc. of the reagent, provided this has been described in N. 2. When the polysulphide is used, 500 mgrms. of any of the common tin-group elements, whether present as the higher or lower sulphide, dissolve in 10 cc. of the reagent. The quantity of SnS and Sb_2S_3 dissolved by the polysulphide increases with its concentration and the excess of sulphur which it contains. A reagent containing a greater excess of sulphur is not used, however, since this would dissolve more CuS and HgS.

*5. Of the rarer elements, gold and platinum divide themselves in the ammonium sulphide treatment between the solution and the residue in a proportion which depends in large measure on the other elements which are present with them. They may therefore be found mainly either with the copper or with the tin group, and should be tested for in the course of the analysis of each group. Molybdenum dissolves in moderate quantity in either ammonium monosulphide or polysulphide, but when a quantity as large as 50 mgrms. is present much of it remains with the copper group; yet there is no danger of not finding a considerable part of it in the tin-group solution, and its presence in the copper-group residue does not interfere with the detection of any of the elements, since it is not precipitated by any of the reagents used. When molybdenum is present, even in as small a quantity as 1 mgrm., the ammonium sulphide solution has an orange-red colour; and this becomes very deep when a moderate quantity is present. Selenium and tellurium pass completely, or almost completely, into the ammonium sulphide solution.

6. Even when a quantity of only 1 or 2 mgrms. of arsenic or antimony is present with a large quantity (even 500 mgrms.) of an element of the copper group, enough is extracted by either the monosulphide or polysulphide to be detected in the subsequent tests. With tin, however, the separation is imperfect; for, when a large quantity of elements of the copper group and only 3 to 5 mgrms. of tin are present, the whole of this may remain undissolved; indeed, when much cadmium is present and the tin is in the stannous state, as much as 15 mgrms. of the latter may be wholly left in the residue, even when the polysulphide is used. On this account it s necessary to test for tin in the course of the analysis of the copper group.

7. Of the sulphides of the copper group none dissolve to a significant extent in the monosulphide. Considerable CuS (5 to 10 mgrms.) and a little HgS (0·5 to 1·0 mgrm.) may, however, dissolve in the polysulphide when the substance contains a large quantity of these elements. Yet when 2 mgrms. of either of these elements are present it can be detected in the analysis of the copper group, even when the polysulphide is used, provided only one treatment with it has been made.

8. Some sulphides, especially CdS, upon washing pass through the filter in the colloidal condition; the addition of a salt, such as NH_4NO_3, prevents this by coagulating the colloidal particles.

(To be continued)

OBITUARY.

GEORGE E. DAVIS.

WE regret to announce the death on Saturday, April 20th, after a short illness, of Mr. George E. Davis, the founder and editor of the *Chemical Trade Journal*.

Mr. Davis was formerly one of Her late Majesty's Inspectors under the Alkali, &c., Works Regulation Acts; he was one of the original Fellows and subsequently a Member of Council of the Institute of Chemistry; a Fellow of the Chemical Society; and he took a prominent part in the inauguration of the Society of Chemical Industry, filling in succession the offices of Honorary Secretary, Member of Council, Chairman of the Manchester Section, and Vice-President.

Mr. Davis contributed largely to chemical, technological, and microscopical literature. His "Handbook of Chemical Engineering" was published in 1901, and his other collected works include "Sizing and Mildew in Cotton Goods" (written in conjunction with Dr. Dreyfus and Mr. Philip Holland, F.C.S.), "The River Irwell and its Tributaries" (of which he was co-author with his brother, Mr. Alfred R. Davis), and numerous other miscellaneous pamphlets, lectures, &c. From its commencement in 1887 he acted as Editor-in-Chief of the *Chemical Trade Journal*. Mr. Davis was in his fifty-seventh year.

Society of Chemical Industry.—Consideration of the Patents and Designs Bill, 1907.—On Friday next, May 10, a critical statement upon this Bill, prepared at the request of the Sectional Committee (London) by the Chairman and Honorary Secretary, will be communicated by the Chairman. A Discussion will follow.

Institute of Chemistry.—*Pass List of the April Examinations, 1907.*—Of seven candidates who entered for the Intermediate Examination, three passed: Eric Hayward, Herbert Mansfield, B.Sc. (Lond.), and C. J. H. Stock, B.Sc. (Dunelm). In the Final Examination for the Associateship (A.I.C), of three candidates examined in the branch of Mineral Chemistry, two passed: F. W. Foreman, and Robert Gillespie, Assoc.R.C.Sc (Lond.); of three in the branch of Metullurgical Chemistry, 2 passed: Edward Cahen, Assoc.R.C.Sc. (Lond.), and C. A. Wonham, BSc. (Lond.); of six in Organic Chemistry, five passed: E. R. Chrystall, B.Sc (Lond.), P. A. Houseman, Ph.D. (Würzburg), Edward Jones, B.Sc. (Wales), F. G. Shepheard, B.Sc. (Lond.), Assoc.R.C.Sc. (Lond), and J. M. Weir, M.A., B.Sc. (St. Andrews); and of six in the branch of the Analysis of Food and Drugs and of Water, including an examination in Therapeutics, Pharmacology, and Microscopy, the following three passed: W. M. Seaber, B.Sc (Lond.), H. L. Smith, B.Sc. (Manchester), and J. H. Totton, B.A., B.Sc. (R.U.I.).

Bismuth Iodide.—Lothar Birckenbach.—No method is known of preparing bismuth iodide in such a state of purity that it can be used for atomic weight determinations. If bismuth and iodine are fused together, the iodide always contains some metallic bismuth, and when prepared in the wet way it is never free from oxyiodide, nor can the perfectly pure substance be obtained by sublimation. If, however, a solution of stannous chloride in hydrochloric acid, saturated with hydrochloric acid gas, is saturated with iodine (which is very soluble in it), and bismuth oxide or oxychloride (in hydrochloric acid solution) is added, the iodide separates out in perfectly pure crystals. The crystals obtained by the author were drained, dried *in vacuo* over calcium chloride, and carefully heated in exhausted glass tubes to a temperature below the melting-point. Thus all impurities were volatilised, and the substance was then twice sublimed in a current of carbon dioxide and hydrogen. Analysis showed that the crystals were the pure iodide, BiI_3.—*Berichte*, xl., No. 6.

NOTICES OF BOOKS.

Physical Chemistry in the Service of Medicine. By Dr. WOLFGANG PAULI. Authorised Translation by Dr. MARTIN H. FISCHER. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1907.

Dr. PAULI is well known as a pioneer in the investigation of the applications of physical chemistry to physiology and pathology, and his work has brought to light such valuable facts that English students of medicine who wish to keep themselves informed of the most recent work will find his book very interesting. The guiding thought which runs through these lectures is the close parallelism of changes in the colloidal state in vitro and in the living organism, and the author expounds more particularly the branch of physical chemistry dealing with energy relations. The fact that he most carefully refrains from stating too definitely as facts those observations which cannot yet be regarded as undoubtly correct makes the book very stimulating, while great originality is displayed in all the discussions of new methods and new points of view. The lectures are valuable both as giving a concise account of Dr. Pauli's own important work and also as providing excellent critical surveys of the comparatively few other investigations of the same branch of physical chemistry.

Practical Paper-making. By GEORGE CLAPPERTON. Second Edition. London: Crosby Lockwood and Son. 1907.

THIS book is above all things practical, tracing the process of paper-making straight through from the grading of the rags to the production of the finished article, and it may be safely said that every page reveals the hand of the paper-maker who has had wide experience and has made the utmost of his opportunities of forming opinions which will be of great value to his fellow manufacturers. As he writes more especially for mill owners and paper-makers, he rather slurs over the chemical knowledge which should be possessed by those who hope to pursue this industry to the greatest advantage, and for this reason the technical student would probably find that the book would require supplementing by one which went more fully into the theory of the chemical processes employed. However, methods of testing the chemicals to be used are given, and rough processes for detecting impurities in water, as well as tests for the ingredients of paper and outlines of the recovery of soda from waste liquors.

Vorträge über die Entwicklungsgeschichte der Chemie von Lavoisier bis zur Gegenwart. ("Lectures on the History of the Development of Chemistry from Lavoisier to the Present Day"). By A. LADENBURG. Fourth Edition. Braunschweig: Friedrich Vieweg und Sohn. 1907.

IT is thirty-eight years since these lectures were first published, and scientific men everywhere will rejoice that Dr. Ladenburg has lived to revise them himself. Needless to say, this long period has seen very important and indeed fundamental developments in all branches of chemistry, which the author chronicles with all his accustomed vigour and vividness of expression. The first six lectures deal with inorganic and general chemistry, beginning with the phlogiston period; then the history of organic chemistry is taken up and treated very clearly, the author regarding it as practically without influence upon the early development of the science, and therefore best considered last. An additional lecture on the most important advances in the present century touches upon the discovery and investigation of radio-activity, the work of Werner upon valency, solid solutions, asymmetric nitrogen, &c., and in very short space gives clear accounts of the most striking points of each subject.

Anleitung für die Manipulationen bei den Barometrischen Höhenmessungen. ("Guide to the Manipulations in the Barometric Measurement of Altitudes"). By JOH. G. SCHOEN. Leipzig and Wien: Franz Deuticke. 1907.

THE author of this pamphlet has had occasion to take many measurements with mercury barometers, comparing the readings with those of aneroids, and now describes in considerable detail the results of his work, which extended over many years. He discusses first of all the choice of an instrument for various purposes, and explains the most convenient methods of transport and the precautions to be observed in moving all kinds of barometers. The taking of observations and application of corrections are fully described, together with the calculation of altitudes from barometric observations, and the pamphlet contains much useful information relating to barometric work in general.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 14, April 8, 1907.

The Nickel-tin Alloys.—Léon Guillet.—The author states that, in addition to the researches on the nickel-tin alloys published by M. Vigouroux, other important work has also been done on the same bodies by himself and others. He gives the following results of his own investigations:—Nickel and tin are capable of forming four solid solutions and one compound. A solution (α), magnetic, containing from 0 to 5 per cent tin; a solution (ε) containing the same amount of tin, but not magnetic; a solution (β) containing 38 to 41 per cent tin; a solution (γ) containing 55 to 60 per cent tin; and, finally, the compound NiSn, consisting of beautiful crystals, visible to the naked eye. The alloys containing less than 38 per cent of tin are only magnetic at the ordinary temperature. All the alloys have transformation-points corresponding to the passage from the magnetic state to the non-magnetic. From the industrial point of view, only these alloys are of interest which form the two extremes, viz., those included in Solution α and those containing 65 per cent tin. These are ductile, and can be subjected to the same mechanical uses as nickel or tin, and possess greater ductility than either of the original metals.

Properties of the Alkaline Protoxides.—E. Rengade.—The alkaline protoxides, prepared in the manner previously described, but with the substitution of glass for the silver vessel used for oxidation and distillation of the alkali metal, present characteristic colorations. The oxides of rubidium, potassium, and sodium are less coloured than that of cæsium; that of rubidium is pale yellow cold, and golden yellow hot; that of potassium white at the ordinary temperature, yellow at 200°; that of sodium slightly yellowish when heated. Determination of the densities of these protoxides, taken in well-dried toluene and referred to water at 0°, gave the following results:—For sodium protoxide $d\ 0° = 2{\cdot}25$; for potassium protoxide, 2·32; for rubidium protoxide, 3·72; for cæsium protoxide, 4·78. The protoxides of cæsium and rubidium, left standing at the ordinary temperature in the tube exhausted of air in which they were prepared, quickly changed in appearance; that of cæsium gradually lost its beautiful red colour and turned black; that of rubidium acquired a copper hue in parts. These colour changes do not occur if the oxides are heated *in vacuo* in a tube containing no alkali metal; and observation has shown that cæsium and rubidium possess a sensible vapour pressure at the ordinary temperature, and that these vapours are absorbed by the corresponding protoxides, though diffusion takes place only very slowly in the vacuum.

Research on the Oxybenzoates. — Œchsner de Coninck.—The author, with the object of ascertaining whether paroxybenzoic acid could be transformed into salicylic acid, investigated the action of heat upon barium paroxybenzoate. Prolonged heating at different temperatures produced no effect until 285° was reached. At this point there was still no formation of salicylic acid, but coloured substances soluble in ether were produced. One of these proved to be a barium carbonate derivative, evolving CO_2 when treated with acids:—

$$\left(C_6H_4{<}^{OH}_{CO_2}\right)_2Ba + 2H_2O =$$
$$= BaCO_3 + 2(C_6H_5OH) + CO_2 + H_2O.$$

If the paroxybenzoate is dry, containing no water of crystallisation, a basic salt, $C_6H_4{<}^{O}_{CO_2}{>}Ba$, is formed, and from this there is also a liberation of phenol and CO_2.

Berichte der Deutschen Chemischen Gesellschaft.
Vol. xl., No. 5, 1907.

Experimental Proof of the Conditions for the Quantitative Equimolecular Transposition of Barium Chloride and Sodium Nitrite in Water.—J. Matuschek.—The author ground together dry barium chloride and sodium nitrite, and found that double decomposition takes place when the two substances are powdered and intimately mixed, and the quantitative decomposition of equimolecular weights of the two substances occurs in aqueous solution, provided that water is not present in excess. The yield of pure barium nitrite is very close to the theoretical yield if the amount of water used as solvent corresponds to only one-third of the calculated weight of the barium nitrite at 100°.

New Apparatus for Melting-point Determinations.—Johannes Thiele.—This consists of a tube of about 2 cm. diameter and length 12 cm., which is bent round in the form of a figure 6, the curved part being connected with the middle of the tube, and having a diameter of 1 cm. The tube is filled with sulphuric acid, so that the upper mouth of the curved part is just closed by it, when the thermometer bulb is half way between the limbs of the curve. When the curved part is heated the sulphuric acid begins to circulate in the apparatus, moving from above downwards in the tube, and producing a very uniform rise in the thermometer reading. The apparatus is far more regular than any other form without a mechanical stirrer; it is heated very quickly, and cools again equally quickly, and is not more easily broken than other apparatus for determining melting-points. As the acid in the tube has a higher temperature above than below, the particles of substance in the upper part of the capillary fuse first, and thus it is easy to see when the neighbourhood of the melting-point has been reached.

Conditions of Fusel Oil Formation and their Connection with the production of Albumen by Yeast.—Felix Ehrlich.—The most important results of the author's work are as follows:—The formation of fusel oil in yeast fermentation is a consequence of the power of the living yeast cell to build up albumen, and proceeds in proportion as the yeast derives nitrogen from definite amino acids (especially leucine, isoleucine, and valine) during the fermentation of the sugar, and leaves behind the corresponding higher alcohols as indigestible metabolic products. From leucine in active isoamyl alcohol is formed from *d*-isoleucine *d*-amyl alcohol, and from valine isobutyl alcohol. The chief sources for the formation of fusel oil are the amino acids partly present as such in the natural maize, and partly split off from the albumen of the raw material. This follows from the fact that certain definite relations hold between the composition of the fusel oils and of the maize. The yield of fusel oil depends upon the amount of leucine present, as well as upon the amount and nature of the other compounds present. The largest quantities of amyl alcohol are obtained if leucine is fermented with pure sugar and pure yeast, poor in nitrogen, in absence of any other compound of nitrogen. By the addition of leucine and its homologues to fermenting maize the amount of fusel oil in the raw spirit can be increased, while the addition of other nitrogen compounds easily assimilated by the yeast would limit or altogether stop the formation of higher alcohols. The formation of fusel oil thus shows for the first time that a natural breaking down of the amino acids, connected with the building up of albumen, is the ordinary process in the life of yeast, and perhaps of other organisms.

Thermic Relations between Ozone, Nitric Oxide, and Hydrogen Peroxide. (III.).—Franz Fischer and Hans Marx.—The authors have continued their experiments on ozone formation with a Nernst pencil in liquid oxygen. An ozone-oxygen solution was obtained, the concentration of which always increased, though at a continually diminishing rate, with the duration of the experiment. The highest concentration amounted to 3·91 per cent of ozone in the liquid oxygen. The process must therefore be regarded as a concentration process. If highly ozonised air is blown on to Nernst pencils the degree of ozonisation is reduced. Hence it follows that only a small part of the air is in contact with the pencil, and is raised to a high temperature; otherwise the same ozonisation would be obtained whether ordinary or highly ionised air was used.

Acetyl Nitrate.—Amé Pictet and Eug. Khotinsky.—To prepare pure acetyl nitrate nitric acid anhydride (obtained by distilling concentrated nitric acid with phosphorus pentoxide) was dissolved in its own weight of acetic acid anhydride. No rise of temperature took place. The acetyl nitrate could be separated from the excess of acetic acid anhydride by fractional distillation under diminished pressure. At 22° and 70 mm. pressure it went over as a colourless mobile liquid which fumes in air. Its specific gravity is 1·24 at 15°. It attracts moisture energetically, and is decomposed by water instantaneously into its components, great heat being evolved. When strongly heated it explodes, and hence its composition cannot be determined by combustion. It was therefore analysed by dissolving in water, determining the total acid by titration and the nitric acid by Kjeldahl's method. It was thus found that the substance is the mixed anhydride of both acids, $CH_3.COO.NO_2$. Acetyl nitrate reacts violently with alcohol, forming the corresponding nitric acid ester and free acetic acid. It acts as an acetylating agent on amines, and nitrates aromatic compounds energetically, the equation being $R.H + CH_3.COO.NO_2 = R.NO_2 + CH_3.COOH$, and is a very convenient reagent to use for this purpose. Substances belonging to the fatty series, for example, chloroform, are also nitrated at higher temperatures. With acetic acid ethyl ester it yields a liquid which is insoluble in cold alkalis, and is saponified by alcoholic potash, forming the potassium salt of nitroform; this liquid is probably trinitro acetic ester.

Brucine Oxide.—Amé Pictet and G. Jenny.—Brucine like strychnine dissolves on gently warming in a 3 per cent solution of hydrogen peroxide. When the liquid cools colourless prisms of the oxide $C_{23}H_{26}N_2O_5 + 4\frac{1}{2}H_2O$ separate out. Brucine oxide containing water fuses at 124—125°, and the anhydrous substance at 199°, undergoing decomposition. It is soluble in alcohol and chloroform, insoluble in ether, petroleum ether, and benzene. It is taken up in the cold by water, forming an intensely bitter solution which is neutral to litmus and phenolphthaleïn. The colour reactions of the oxide (with nitric acid, stannous chloride, ammonium sulphide, sulphurous acid, potassium bichromate) are the same as those of brucine itself. It is converted into brucine by the action of sulphurous acid. It is a monatomic base, forming brucine oxide salts which are more soluble in water than those of

strychnine oxide. They are lævo-rotatory like the base itself, and are converted into brucine salts by reducing agents, such as sulphurous acid.

MEETINGS FOR THE WEEK.

MONDAY, 6th.—Society of Chemical Industry, 8. "The Works Chemist as Engineer," by O. Guttmann.
—— Royal Institution, 5. General Monthly Meeting.
TUESDAY, 7th.—Royal Institution, 3. "Stimulation, Luminous and Chemical," by Prof. William Stirling, M.D., &c.
WEDNESDAY, 8th.—Society of Arts, 8. "The Production of Coke and its Application in Domestic Fires," by Paul Schlicht.
THURSDAY, 9th.—Royal Institution, 3. "Spectroscopic Phenomena in Stars," by H. F. Newall, F.R.S., &c.
FRIDAY, 10th.—Royal Institution, 9. "Recent Excavations on the Forum Romanum and the Forum Ulpium," by Signor Come Giacomo Boni.
—— Society of Chemical Industry, 8. Critical Statement upon, and Discussion of, "The Patents and Designs Bill, 1907."
—— Physical, 8. Stereoscopy with Long Base-line Illustrated on the Screen, by T. C. Porter.
SATURDAY, 11th.—Royal Institution, 3. "Scientific Work in the Sea Fisheries," by Prof. W. C. McIntosh.

ERRATUM.—P. 193, col. 2, line 32, *for* "may not give" *read* "may give."

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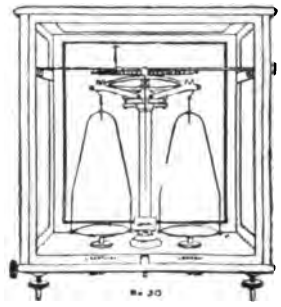

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THE CHEMICAL NEWS.

VOL. XCV., No. 2476.

FOURTEENTH ANNUAL REPORT OF THE COMMITTEE ON ATOMIC WEIGHTS.

DETERMINATIONS PUBLISHED DURING 1906.*

By F. W. CLARKE.

(Concluded from p. 210).

Copper.

IN order to determine the atomic weight of copper, Murmann (*Monatsh.*, xxvii., 351) made a series of experiments upon the oxidation of the metal by prolonged heating in a stream of air, followed by a series of reductions in hydrogen of the oxide so formed. His results range from Cu = 63·513 to Cu = 64·397, and are therefore too discordant to have much significance. The best determinations ran from 63·513 to 63·560, the value 63·53 being regarded by Murmann as the most probable. The individual data are given so confusedly that it is not desirable to attempt their reproduction here.

Cadmium.

The paper on cadmium by Baxter, Hines, and Frevert (*Journ. Am. Chem. Soc.*, xxviii., 770) is a continuation of a research which was published last year. Analysis of the bromide gave the following results when Ag = 107·93 and Br = 79·955 :—

Weight $CdBr_2$.	Weight AgBr.	Weight Ag.	Atomic weight Cd. AgBr ratio.	Atomic weight Cd. Ag ratio.
11·46216	15·81319	9·08379	112·466	112·468
6·82282	9·41267	5·40724	112·469	112·461
6·75420	9·31830	5·35277	112·460	112·465
7·08588	9·77649	5·61597	*112·444	*112·449
5·13859	7·08933	4·07226	112·461	112·473
5·84324	8·06130	4·63072	112·467	112·471
5·99704	8·27360	4·75259	112·463	112·472
5·90796	8·15070	4·68200	112·463	112·472
Mean, rejecting the starred values ..			112·464	112·467

New analyses of the chloride gave data as follows, when Cl = 35·473.

Weight $CdCl_2$.	Weight AgCl.	Weight Ag.	Atomic weight Cd. AgCl ratio	Atomic weight Cd. Ag ratio.
5·62500	—	6·61193	—	112·472
6·81031	10·64918	8·01496	112·471	112·470
5·50089	8·60174	6·47393	112·469	112·470
6·11750	9·56590	—	112·470	—
		Mean	112·470	112·471

The final conclusion is that Cd = 112·47. All weights were reduced to a vacuum.

Tellurium.

The investigation by Norris (*Journ. Am. Chem. Soc.*, xxviii., 1675) was primarily to determine the definiteness of tellurium as an element by fractional processes which would prove the presence or absence of any other substance, such as the hypothetical "dvitellurium" of Mendeleeff. The integrity of the element having been established, the atomic weight determinations followed. The basic nitrate, $2TeO_2.HNO_3$, dried at 140° in a current of dry air, was decomposed by heating gradually, at last to 400—450°. The weights thus obtained are given below. The atomic weight, reduced to a vacuum standard, was computed with H = 1·0076 and N = 14·01.

Weight nitrate.	Weight TeO_2.	Atomic weight Te.
2·28215	1·90578	127·47
2·35429	1·96615	127·53
1·86853	1·56042	127·49
1·77348	1·48110	127·49
2·31048	1·92938	127·44
2·14267	1·78936	127·50
2·35523	1·96676	127·45
2·18860	1·82780	127·54
3·29158	2·74881	127·50
2·27516	1·89993	127·46
2·53164	2·11410	127·46
2·01327	1·68121	127·45
	Mean	127·48

Without reduction to vacuum and with N = 14·04, Te = 127·64. Köthner, under these conditions, found Te = 127·63, and his data, reduced, became Te = 127·47. The two series of determinations are therefore in good accord, but differ materially from recent measurements by other methods, which agree in making Te = 127·60. The cause of this difference is unexplained.

Bismuth.

In the report for 1905, a dissertation by Birckenbach was noticed, which contained determinations of atomic weight made under the direction of Gutbier at Erlangen. Two more dissertations from the same laboratory have since appeared, giving additional determinations by other methods.

Mehler determined the ratio between bismuth bromide and silver bromide (Doctoral Dissertation, Erlangen, 1905). The results obtained, with vacuum weights, are subjoined. The computation was based upon Br = 79·96, Ag = 107·934.

Weight $BiBr_3$.	Weight AgBr.	Atomic weight Bi.
3·77071	4·74323	208·24
4·37676	5·50932	207·92
8·64088	4·58160	208·05
4·57894	5·76183	208·08
4·53204	5·70410	208·89
2·85054	3·58682	208·10
4·58310	5·76618	208·14
6·47910	8·15465	207·99
	Mean	208·05

In the other investigation, by Janssen (Doctoral Dissertation, Erlangen, 1906), the synthesis of bismuth sulphate from the metal was effected. The metal was first dissolved in nitric acid, and then treated with sulphuric acid, with various precautions which cannot be discussed here. The final data are as follows, reduced with S = 32·06 :—

Weight Bi.	Weight sulphate.	Atomic weight Bi.
2·4045	4·0706	207·951
2·41900	4·09445	208·040
2·20280	3·72745	208·178
2·57206	4·35444	207·928
5·79241	9·79987	208·266
3·65233	6·18143	208·082
	Mean	208·074

Although the data given by Mehler and Janssen are by no means sharply concordant, they corroborate the results obtained by Birckenbach, and agree with the earlier determinations of Löwe, Schneider, and Marignac. For practical purposes the even value Bi = 208 may be employed.

Palladium.

In order to determine the atomic weight of palladium, Krell (Doctoral Dissertation, Erlangen, 1906) reduced weighed quantities of palladosamine chloride, $PdN_2H_6Cl_2$, by heating in hydrogen. The reduced palladium was

* From the *Journal of the American Chemical Society*, xxix., No. 3.

afterwards heated in a stream of carbon dioxide, in order to free it from occluded hydrogen. The data given are as follows, with vacuum weights:—

Weight chloride.	Weight Pd.	Per cent Pd.	Atomic weight Pd.
1·83034	0·92197	50·372	106·59
1·73474	0·87433	50·401	106·72
1·92532	0·96524	50·396	106·72
2·63544	1·32868	50·416	106·78
3·23840	1·63175	50·387	106·66
		Mean	106·694

If the first experiment is rejected, this becomes 106·72. The atomic weights used were those of the International Committee for 1906.

Tantalum.

Hinrichsen and Sahlbom (*Ber.*, xxxix., 2600) have determined the atomic weight of tantalum by oxidising the metal to pentoxide. The metal was obtained from Siemens and Halske, and contained no appreciable impurity. The oxidation was effected by direct heating in oxygen. The results obtained, with vacuum weights and with O = 16, were as follows:—

Weight Ta.	Weight Ta_2O_5.	Atomic weight Ta.
0·37200	0·45437	180·65
0·41278	0·50364	181·77
0·33558	0·40975	180·98
0·35883	0·43807	181·14
0·47554	0·58087	180·59
	Mean	181·03

From the sum of the weights the authors deduce Ta = 180·98, or 181 in round numbers. Potassium tantalifluoride was investigated and found to be unsuitable for good atomic weight determinations.

THE RARE EARTHS.

During 1906 an unusual number of determinations have been published relative to the atomic weights of the rare earth metals. First, Urbain (*Comptes Rendus*, cxlii., 957) has made a good determination of the atomic weight of terbium by estimating the amount of water in the octohydrated sulphate. The amount of oxide was not determined because the product obtained on igniting the sulphate varied in composition. The data are subjoined:—

Weight octohydrate.	Anhydrous sulphate.	Atomic weight Tb.
2·0407	1·6489	159·20
1·9626	1·5859	159·30
2·2580	1·8245	159·19
2·2385	1·8087	159·17
2·0037	1·6190	159·19
	Mean	159·22

Calculated with H = 1·007 and S = 32·06. Hinrichs, rediscussing these data, argues in favour of Tb = 159 (*Comptes Rendus*, cxliii., 1196).

Two series of determinations by Urbain and Demenitroux relate to dysprosium (*Comptes Rendus*, cxliii., 598; preliminary in cxlii., 727). They represent different fractions of the material studied, and were obtained by the ignition of the octohydrated sulphate.

First Series.

Weight sulphate.	Weight Dy_2O_3.	Atomic weight Dy.
1·1966	0·8359	162·61
2·0926	1·0301	162·29
1·8415	0·9069	162·45
1·5519	0·7649	162·75
2·4955	1·2296	162·64
1·8130	0·8927	162·39
	Mean	162·52

Second Series.

Weight sulphate.	Weight Dy_2O_3.	Atomic weight Dy.
1·8817	0·9271	162·61
1·1164	0·5500	162·59
1·7308	0·8528	162·63
2·6038	1·2820	162·36
1·6942	0·8346	162·56
2·1776	1·0726	162·52
	Mean	162·54

This paper was followed by a communication from Hinrichs, who attempts to show that Dy = 162·5 exactly (*Comptes Rendus*, cxliii., 1143).

O. Holmberg, in a doctoral dissertation (*Akademisk Afhandling, Upsala*, 1906), has given a series of determinations of the atomic weight of neodymium. The data, representing syntheses of the sulphate from the oxide, are subjoined:—

Weight Nd_2O_3.	Weight $Nd_2(SO_4)_3$.	Atomic weight Nd.
0·9692	1·6618	144·05
0·6584	1·1287	144·12
1·0292	1·7643	144·13
1·0118	1·7346	144·10
0·5518	0·9462	144·01
0·5345	0·9164	144·07
	Mean	144·08

Feit and Przibylla, by a special volumetric method, have re-determined the atomic weights of several rare earth metals (*Zeit. Anorg. Chem.*, l., 249). The oxides were dissolved in definite weighed quantities of half-normal sulphuric acid, and the slight excess of the latter was determined by titration with a decinormal solution of sodium carbonate. From the amount of acid required to form neutral salts, the authors compute the amount of oxygen in the oxides, and thence deduce the atomic weight of the elements. The data, somewhat condensed from the original, are as follows:—

Lanthanum.

Weight La_2O_3.	Oxygen.	Atomic weight La.
0·5125	0·07544	139·05
0·5256	0·07731	139·11
0·4835	0·07116	139·08
0·5235	0·07706	139·04
0·4815	0·07088	139·03
0·5156	0·07585	139·15
0·5348	0·07867	139·15
	Mean	139·09

Reduced to a vacuum standard, La = 139·17.

Praseodymium.

Weight Pr_2O_3.	Oxygen.	Atomic weight Pr.
0·54010	0·07879	140·51
0·53240	0·07789	140·60
0·50054	0·07302	140·51
	Mean	140·54
	With vacuum weights ..	140·62

Neodymium.

Weight Nd_2O_3.	Oxygen.	Atomic weight Nd.
0·5380	0·07661	144·54
0·5388	0·07675	144·48
0·5358	0·07632	144·49
0·5265	0·07497	144·56
	Mean	144·52
	With vacuum weights ..	144·60

Samarium.

Weight Sa_2O_3.	Oxygen.	Atomic weight Sa.
0·5576	0·07668	150·53
0·5576	0·07670	150·47
0·5583	0·07684	150·38
0·5633	0·07747	150·51
	Mean	150·47
	With vacuum weights ..	150·56

Europium.

Weight Eu_2O_3.	Oxygen.	Atomic weight Eu.
0·3961	0·05835	152·54
0·4096	0·05566	152·62
0·4115	0·05594	152·56
	Mean	152·57
	With vacuum weights ..	152·66

Gadolinium.

Weight Gd_2O_3.	Oxygen.	Atomic weight Gd.
0·3852	0·05097	157·37
0·3956	0·05234	157·40
	Mean	157·38
	With vacuum weights ..	157·47

Ytterbium.

Weight Yb_2O_3.	Oxygen.	Atomic weight Yb.
0·6424	0·07808	173·46
0·6408	0·07783	173·60
0·6403	0·07779	173·55
0·6466	0·07858	173·48
	Mean	173·52
	With vacuum weights ..	173·52

Yttrium.

Two sets of determinations were made on two different preparations. They are here treated as one.

Weight Yt_2O_3.	Oxygen.	Atomic weight Yt.
0·3677	0·07781	89·42
0·4928	0·10438	89·31
0·3660	0·07749	89·36
0·3660	0·07751	89·33
0·3704	0·07840	89·39
0·3635	0·07701	89·29
	Mean	89·35
	With vacuum weights ..	89·40

In Abegg's "Handbuch der Anorganischen Chemie" a series of excellent summaries of atomic weight determinations, written by Brauner, has appeared. In the sections relative to the rare earth metals (Band 3, Abth. 1, pp. 263, 276, 284, 304, 318, 335) Brauner gives some previously unpublished data of his own, which can be briefly summarised as follows:—

Praseodymium.

Atomic weight determined by four methods.

First, reduction of the octohydrated sulphate to oxide.

Weight sulphate.	Weight oxide.	Atomic weight Pr.
1·29269	0·59747	141·13
1·27990	0·59137	141·04
	Mean	141·09

Second, analysis of the anhydrous sulphate.

1·03242	0·59747	140·96
1·02193	0·59137	140·94
	Mean	140·95

Third, synthesis of the sulphate from the oxide.

1·26782	0·73359	140·91
0·12059	0·64871	141·09
1·28051	0·74103	140·96
1·25792	0·72894	140·92
0·63350	0·36559	140·94
1·43024	0·82769	140·96
	Mean	140·96

Fourth, analysis of the oxalate. The Pr_2O_3 in each sample of the oxalate was determined, and also, volumetrically, by titration with potassium permanganate, the amount of C_2O_3. The *mean* results are given below for four different samples of oxalate.

Per cent Pr_2O_3.	Per cent C_2O_3.	Atomic weight Pr.
45·183	29·581	140·96
45·090	25·517	140·98
45·0775	29·493	141·07
45·136	29·5635	140·89
	Mean	140·98

Brauner regards Pr = 140·96 as the best value for Pr, which may be rounded off to 141·0.

Neodymium.

Three syntheses of the sulphate are given, from different samples of the oxide. The last one, which Brauner regards as trustworthy, is as follows:—

0·93788 grm. Nd_2O_3 gave 1·60873 $Nd_2(SO_4)_3$. Hence Nd = 143·89.

Samarium.

Analysis of the sulphate.

1·36567 grm. $Sa_2(SO_4)_3.8H_2O$ gave 1·09770 $Sa_2(SO_4)_3$. Sa = 150·76.

1·09770 $Sa_2(SO_4)_3$ gave 0·65046 Sa_2O_3. Sa = 150·66. Mean, 150·71.

As the material was not entirely free from europium this value is too high.

Gadolinium.

0·8888$_4$ Gd_2O_3 gave 1·48257 $Gd_2(SO_4)_3$ and 1·83903 $Gd_2(SO_4)_3.8H_2O$. Hence, Gd = 155·78, which is somewhat too low.

Erbium.

1·09395 Er_2O_3 gave 2·53997 $Er_2(SO_4)_3$. Er = 167·14.

Ytterbium.

1·067279 Yb_2O_3 gave 2·69209 $Yb_2(SO_4)_3$. Yb = 173·08.

Baxter and Griffin (*Journ. Am. Chem. Soc.*, xxviii., 1684) have shown that the oxalates of the rare earths, under certain conditions, carry down ammonium oxalate. This possibility should be borne in mind in any determination of atomic weights by the oxalate method.

Wyrouboff and Verneuil, in a long paper upon cerium (*Ann. Chim. Phys.*, [8], ix., 349), reproduce their determinations of 1897, and defend them against criticisms. No new determinations are given.

Some additional information upon thorium, berzelium, and carolinium has been published by Baskerville ("Fourth Annual Report Carnegie Institution," p. 136; and Fifth Report, p. 144). The report is one of progress, without final results.

MISCELLANEOUS NOTES.

Bradbury (CHEMICAL NEWS, xciv., 157 and 245) has pointed out certain relations between the atomic weights of several elements, but his results do not seem to have any great importance. There is also a memoir by Hinrichs, in which he reiterates his well-known views in favour of whole number atomic weights and criticises the modern determinations (*Chem. Cent.*, 1906, i., 197; abstract from the *Moniteur Scientifique*, which I have not seen).

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

PART II.—ANALYSIS OF THE SILVER, COPPER, AND TIN GROUPS.

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 213).

PROCEDURES AND NOTES (*continued*).

Analysis of the Copper Group.

Procedure 23.—To the residue from the ammonium sulphide treatment (P. 22) in a casserole add 10 to 20 cc. of a mixture of one volume HNO_3 (1·20) and two volumes water, heat to boiling, aud boil gently for a minute or two. (Black residue, possible presence of *mercury*). Filter and wash. (Residue, P. 24; solution, P. 26).

Notes.

1. Boiling HNO_3 of this concentration dissolves the sulphides of lead, bismuth, copper, and cadmium almost immediately, and is therefore preferable to a more dilute acid, with which the reaction would require for its completion several minutes' boiling. Scarcely any HgS is dissolved by the above treatment, unless the boiling is long continued.

2. Moderately concentrated HNO_3 dissolves sulphides much more rapidly than HCl or H_2SO_4 of the same concentration; for with the latter acids the sulphide ion is removed from the solution only by combination with the hydrogen ion forming slightly ionised H_2S and by the volatilisation of the latter, while with HNO_3 the sulphide ion (or the H_2S in equilibrium with it) may also be destroyed by oxidation to ordinary sulphur. The oxidising effect of HNO_3 is, however, considerable only when it is hot and moderately concentrated.

3. That HgS, unlike the other sulphides, does not dissolve in the dilute HNO_3 is doubtless due to the much smaller concentration of its ions in its saturated solution and to the fact that at this small concentration the sulphide ion (or the H_2S in equilibrium with it at a correspondingly small concentration) is oxidised only very slowly by the dilute HNO_3. HgS is, however, readily dissolved by more vigorous oxidising agents, such as aqua regia or bromine water, since they react rapidly with sulphide ion (or with H_2S) even when its concentration is very small.

4. If more concentrated HNO_3 be used, or if the acid become concentrated by long boiling, the black HgS is dissolved in part, and the remainder is converted into a heavy, white, difficultly soluble compound, $Hg(NO_3)_2.2HgS$.

5. When much lead, copper, or bismuth is present the su phur formed will generally enclose enough of the undissolved sulphide to give it a black colour. [*Moreover, PtS_2 and Au or Au_2S, if present, are not dissolved by the HNO_3. A black residue is therefore not necessarily HgS, and must be further tested for mercury as described in P. 24.

6. Some sulphur is always oxidised to H_2SO_4 by the boiling HNO_3, but, even in the presence of much lead, $PbSO_4$ is not precipitated, owing to its moderate solubility in HNO_3.

7. Any SnS or SnS_2 not extracted by the ammonium sulphide treatment will be converted by HNO_3 into metastannic acid, most of which remains undissolved. Therefore even a light coloured residue must be carefully collected if tin is to be tested for in this group.

Procedure 24.—Transfer the residue undissolved by HNO_3 (P. 23), with the filter if necessary, to a casserole, add 10 to 40 cc. saturated Br_2 solution, cover the dish, and warm slightly for five to ten minutes, with frequent stirring. Boil the mixture until the bromine is expelled, and filter. (Residue, P. 25). [*If the solution is yellow, indicating that gold or platinum may be present, treat it by *P. 24*a*, and then proceed as follows] :—Cool the solution, and add to it a few drops of HCl (1·12) and a 2 per cent $SnCl_2$ solution. at first drop by drop; then add several cc. of a 10 per cent $SnCl_2$ solution. (White precipitate turning grey, or grey precipitate, presence of *mercury*). (Residue and solution, reject.

Notes.

1. Bromine water dissolves the sulphides of mercury, platinum, and gold, but leaves in the residue any metastannic acid. In case tin need not be tested for at this point, the residue may be more quickly dissolved by warming it with HCl (1·12), and adding gradually a little solid $KClO_3$; since metastannic acid is soluble in HCl, this then passes into solution with the mercuric salt.

2. In the final test for mercury HCl is added to prevent the precipitation of a basic tin salt when the $SnCl_2$ reagent is diluted, and to cause the formation at first of white Hg_2Br_2 or Hg_2Cl_2. For the latter reason, also, dilute $SnCl_2$ solution is added drop by drop to the cold solution. By the excess of $SnCl_2$ the white precipitate is reduced to grey finely divided mercury.

3. The presence of mercury at this point does not show that it was originally in the mercuric state, except in case the substance was dissolved without the use of hot or concentrated HNO_3. If it is desired to determine in which state the mercury was originally present, a solution of the substance in water, in dilute H_2SO_4, or in cold very dilute HNO_3, must be prepared and analysed for mercurous and mercuric mercury by the regular process, beginning with P. 11.

*4. Platinum and gold compounds, if not remove l, are reduced by $SnCl_2$, the former giving a reddish brown solution and the latter a dark coloured or purple precipitate of metallic gold. The presence of these elements would thus interfere with, or prevent the detection of, mercury, and it is therefore directed to remove them.

**Procedure* 24*a*.—To the solution of the sulphides in bromine water (P. 24) add about 0·5 grm. solid KCl and 1 to 2 cc. HCl (1·12), evaporate until KCl crystallises out, cool, and add water drop by drop until almost all the KCl has dissolved. (Yellow precipitate, presence of *platinum*). Filter and wash with a little saturated KCl solution. Confirm the presence of platinum in the precipitate by *P 43*a*. To the filtrate add 10 per cent NaOH solution till alkaline, and then about 1 cc. more. Then add saturated oxalic acid ($H_2C_2O_4$) solution until the solution becomes distinctly acid, dilute to about 15 cc., and digest on a steam-bath for ten to fifteen minutes. (Purplish black or dark yellow precipitate, presence of *gold*). Filter. Reject the precipitate. Test the filtrate for mercury with $SnCl_2$ solution by the last part of P. 24.

Note.

1. For notes upon this process, see under *P 43*a* and 43*b*. By means of it can be detected 1 mgrm. of gold :r platinum in the presence of much mercury (at least 200 mgrms.), or 1 mgrm. of mercury in the presence of much gold or platinum.

Procedure 25.—If it is necessary to extract tin (see N. 1 below) from the residue undissolved by HNO_3 and bromine water (P. 24), digest it, if it is still dark coloured, with another portion of bromine water to extract the rest of the mercury, filter, r ject the filtrate, and warm the residue slightly with 2 to 5 cc. ammonium monosulphide, filter, and unite the solution with the main ammonium sulphide solution obtained in P. 22.

Note.

1. If it is desired to detect with certainty the presence in the substance of a quantity of tin smaller than 5 mgrms., and if the elements of the copper group are

* From the *Technology Quarterly*, xix., No. 3, September, 1906.

present in large quantity (100 to 500 mgrms.), it is necessary to recover the tin that remained with the copper group; for, as stated in P. 22, N. 5, a quantity of tin as large as 5 mgrms. (or even larger when stannous tin and cadmium are both present) may remain entirely in the residue undissolved by ammonium sulphide when this residue is large. By extracting the tin as described in this procedure and uniting it with the main solution of the tin group 2 mgrms. of tin can be detected.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Annual General Meeting, March 22nd, 1907.

Prof. R. MELDOLA, F.R.S., President, in the Chair.

DR. G. D. LANDER and Dr. J. F. Thorpe were appointed scrutators, and the Ballot was opened for the election of Officers and Council for the ensuing year.

The PRESIDENT presented the Report of the Council on the progress of the Society during the past twelve months. The adoption of the Report of the Council was proposed by Prof. J. B. HARRISON, seconded by Prof. W. JACKSON POPE, and carried unanimously.

Report of the Council.

The Council has the satisfaction of being able to report the continued prosperity of the Society, and that, measured by the number of papers read and the number of Fellows on the list, there has been greater activity than in any previous year.

On December 31st, 1905, the number of Fellows was 2785. During 1906, 172 Fellows were elected, and 2 reinstated, thus making a gross total of 2959. The Society has lost 24 Fellows by death; 24 have resigned, the elections of 5 have become void; 39 have been removed for non-payment of Annual Subscriptions, and 7 Life Compounders, whose addresses could not be found, have been removed.

The total number of Fellows, therefore, on December 31st, 1906, was 2860, showing an increase of 75 over the number for the previous year.

The names of the deceased Fellows, with the dates of their election, are:—W. H. Chandler (1872), F. J. Claudet (1852), T. S. Davis (1876), W. H. Edwards (1902), M. H. Foye (1884), C. H. B. Hambly (1859), J. G. Hepburn (1853), J. S. C. Heywood (1848), G. H. Hurst (1885), F. M. Lyte (1859), C. W. Marsh (1881), E. H. Miller (1897), W. J. Orsman (1884). B. Phillips (1889), J. E. Pitman (1906), T. Royle (1862), F. Smith (1890), T. D. Smith (1898), H. J. P. Sprengel (1864), W. S. Squire (1858), J. A. Storey (1891), C. Tookey (1855), T. B. Tyson (1885), Maj.-Gen. A. Walker (1868).

The number of the Fellows who were elected in the early part of the last century has been still further diminished by the death of Mr. F. J. Claudet, elected on February 16th, 1852; Mr. J. G. Hepburn, elected on February 21st, 1853; and of Mr. J. S. C. Heywood, who was elected on April 3rd, 1848.

The number of Honorary and Foreign Members at the close of 1905 was 34. No elections have been held during 1906, but the Society has to mourn the loss of Dr. Fedor Beilstein, who was elected February 1st, 1883, and who died on October 19th, 1906. The number of Honorary and Foreign Members at December 31st, 1906, was therefore 33.

Since the close of 1906, the Society has lost by death three more of its Honorary and Foreign Members, namely, Prof. Dr. D. I. Mendeleeff (on February 2nd), Prof. Dr. Nicolai Menschutkin (on February 4th), and Prof. Henri Moissan (on February 20th).

During the year 1906, 236 scientific communications have been made to the Society, 176 of which have been published already in the *Transactions*, and abstracts of all have appeared in the *Proceedings*.

The volume of *Transactions* for 1906 contains 1943 pages, of which 1890 are occupied by 186 memoirs, the remaining 53 pages being devoted to the Cleve Memorial Lecture, the Report of the Annual General Meeting, and the Presidential Address; the volume for the preceding year contains 184 memoirs, which occupy 1818 pages.

The Journal for 1906 contains also 4541 abstracts of papers, published mainly in foreign journals, which extend to 1912 pages, whilst the abstracts for 1905 numbered 4356, and occupied 1828 pages.

The abstracts for 1906 may be classified as follows:—

	Pages.	No. of Abstracts.
PART I.		
Organic Chemistry	1000	1745
PART II.		
General and Physical Chemistry ..		651
Inorganic Chemistry..		559
Mineralogical Chemistry..		128
Physiological Chemistry		486
Chemistry of Vegetable Physiology and Agriculture		343
Analytical Chemistry		629
	912	2796
Total in Parts I. and II. ..	1912	4541

Among the first acts of the Council elected in March, 1906, was the appointment of a Finance Committee, and it was decided also that the names of the Members, together with those of the House, Library, Publication, and Research Fund Committees, should be read from the Chair at the Ordinary Meeting next after the Meeting of Council at which the Committees are formed.

In the previous Session, and on a second occasion during the present one, the desirability of reading the minutes at an Ordinary Meeting has been called in question; for the guidance of Chairmen on this point it has been resolved that henceforth the minutes must be read as long as the present by-laws remain in force.

The practice of holding the Ordinary Meetings of the Society on the first and third Thursdays of the month, reversion to which was announced in the last Annual Report, appears justified by the average attendance of Fellows, which has been well maintained. In order to relieve the pressure of business which has been usual at the first and last Meetings of the Session, it was decided to hold two extra Meetings, in October and July respectively.

The triennial award of the Longstaff Medal to the Fellow of the Society who, in the opinion of the Council, has done the most to promote Chemical Science by Research, was made, on the recommendation of the Research Fund Committee, to Prof. Walter Noel Hartley, F.R.S., in recognition of his spectrochemical investigations. The medal was presented on October 18th, 1906.

On the occasion of the International Celebration marking the Fiftieth Anniversary of the Foundation of the Coal-tar Colour Industry, an Address of congratulation to Sir William Henry Perkin, F.R.S., was presented on behalf of the Society by the President. In accordance with the resolution of the public meeting at which the commemoration was inaugurated, a marble bust of Sir William Perkin, executed by Mr. F. W. Pomeroy, A.R.A., has been presented to the Society by the Committee administering the Fund subscribed in support of the celebration.

The Society has also received a Berzelius medal cast in selenium, presented by Mr. John Spiller, and Prof. J. M. Thomson, F.R.S., has presented an aqua-tint engraving of Dr. Thomas Thomson, F.R.S., Regius Professor of Chemistry in the University of Glasgow from 1818 to 1852.

During the vacation of 1906 an Address was presented to the University of Aberdeen at the celebration of its Fourth Centenary, which took place in September. The congratulations of the Society were offered also to the distinguished Honorary and Foreign Member, Prof. Adolph Lieben, on the occasion of his seventieth birthday and fiftieth anniversary of his doctorate.

The desirability of applying for a supplemental Charter with a view to removing existing restrictions in regard to nationality and sex as affecting election to the Fellowship of the Society has been carefully considered by the Council. After receiving the report of a Special Committee, consisting of Mr. Phipson Beale, Mr. Bousfield, Dr. Horace Brown, Dr. Moody, Prof. Emerson Reynolds, Dr. T. E. Thorpe, Prof. W. A. Tilden, and the Officers, the Council resolved that for the guidance of Chairmen, only those Fellows who are British subjects can vote at meetings or be eligible for offices, and that the matter be made clear by adding to the gloss on the Charter, after the first paragraph, the words "but British subjects who are Fellows can alone exercise corporate rights, or be eligible for office."

The Council has resolved that, following the ordinary index of the *Transactions*, there shall appear a list of new compounds described in the original communications, tabulated according to the Richter system.

The alchemical and early chemical works presented to the Library by Sir Henry E. Roscoe have been catalogued (*Proc.*, 1906, xxii., 209—233), and the volumes placed in a special book-case.

The number of books borrowed from the Library during 1906 was 1126, as against 1108 in the previous year. The additions to the Library comprise—(*a*) a collection of 136 alchemical and other books presented by Sir Henry E. Roscoe; (*b*) 121 books, of which 64 were presented, 385 volumes of periodicals, and 32 pamphlets, as against 165 books, 324 volumes of periodicals, and 48 pamphlets last year.

In January last the Council decided that during the remainder of the present Session the Library shall be kept open for the use of Fellows every Thursday from 10 a.m. until 9 p.m., except on those evenings on which the Society meets, when it will remain open until 10.30 p.m.

The annual income of the Research Fund from its investments is £219 17s., and from this grants amounting to £210, as well as the Longstaff Honorarium and Medal, had to be paid. That this should be not only possible, but that there should also be an excess of income over expenditure of £26 13s. 11d. for the year, is due to the amount of £38 6s. 11d. having been returned from grants made in previous years. In the *Transactions* for 1906 there are 31 papers contributed by authors to whom grants had been made from the Research Fund.

The Treasurer has great pleasure in recording that in February of the present year the Society received a further munificent donation of £1000 to the Research Fund from the Worshipful Company of Goldsmiths. The income accruing from this donation will, in accordance with the expressed wish of the donors, be devoted especially to the encouragement of research in metallurgy and inorganic chemistry.

The financial transactions of the Society for the past year have been very satisfactory, and show a substantial surplus. The total income of the Society for 1906 is £7121 8s. 11d., being an increase of £327 14s. 11d. over that for 1905 (£6793 14s.) in spite of the fact that the amount received on account of Life Composition Fees has fallen from £360 to £268, a decrease of £92. The increase in income is mainly composed of the following three items:—(1) Admission fees, £120; (2) annual subscriptions, £138 18s.; and (3) sale of publications, £120 6s. 3d. Whilst the income has notably increased, the expenditure has fallen much more considerably, and is £718 19s. 8d. less than last year, so that instead of a deficit of £305 1s. 5d. on the year's working there is a surplus of £741 13s. 2d., a difference in all of £1046 14s. 7d. This is due very largely to having no expenses of any kind to meet on account of the Collective Index, which last year alone cost the Society £778 10s. 5d., but it must not be thought that nothing is being done towards the preparation of the next volume, because the card indexes now made by Mrs. Dougal for each Annual Index will, with comparative little expense and labour, be blended together and thus utilised for the preparation of Vol. V. of the Collective Index, which will cover the period 1903-1912.

The cost of the *Journal*, the *Proceedings*, and the *Annual Reports* all show increased expenditure, amounting to £71 7s. 6d., £40 6s., and £68 10s. 7d. respectively. It is very satisfactory to notice that although the *Transactions* and *Abstracts* show an increase of over 200 pages and contain several lengthy, as well as important and expensive, papers, the increase in cost should be so small. In this connection the Treasurer has to thank Prof. Pope and Mr. Barlow for supplying all the blocks required to illustrate their paper published in the November issue of the *Journal*. The increased cost of the *Proceedings* is due in part to the issue of two additional numbers corresponding to the two extra meetings of the Society in July and in October, and in part also to the printing of the catalogue, compiled with great care by the Librarian, of the collection of alchemical works above referred to which the Society owes to the generosity of Sir H. E. Roscoe, and which are now properly housed in the Library.

The balance sheet also shows that a small legacy of £33 12s. 3d. has been received under the will of the late Mr. Henry Dircks, and is a residue of the estate from which almost exactly thirty years ago the Society received £840 5s.

The TREASURER gave a statement as to the Society's Income and Expenditure during the year 1906, and proposed a vote of thanks to the Auditors, which was seconded by Dr. W. R. E. HODGKINSON and carried unanimously. Acknowledgment was made by Mr. E. GRANT HOOPER.

A vote of thanks to the Treasurer, Secretaries, Foreign Secretary, and Council for their services during the past year was proposed by Sir WILLIAM H. PERKIN, seconded by Dr. E. DIVERS, and adopted unanimously; this was acknowledged by Sir WILLIAM RAMSAY.

The PRESIDENT then delivered his Address, entitled "The Position and Prospects of Chemical Research in Great Britain. Dr. T. E. THORPE proposed a vote of thanks to the President coupled with the request that he would allow it to be printed in the Society's *Transactions*.

The motion was seconded by Prof. J. MILLAR THOMSON and carried with acclamation, the PRESIDENT making acknowledgment.

The Scrutators then presented their Report to the Chairman, who declared that the following had been duly elected as Officers and Council for the ensuing year:—

President—Sir William Ramsay, K.C.B., F.R.S.

Vice-Presidents who have filled the office of President—H. E. Armstrong, Ph.D., LL.D., F.R.S.; A. Crum Brown, D.Sc., LL.D., F.R.S.; Sir William Crookes, D.Sc., F.R.S.; Sir James Dewar, M.A., LL.D., F.R.S.; A. Vernon Harcourt, M.A., D.C.L., F.R.S.; Raphael Meldola, F.R.S.; H. Muller, Ph.D., LL.D., F.R.S.; W. Odling, M.A., M.B., F.R.S.; Sir W. H. Perkin, Ph.D., LL.D., F.R.S.; J. Emerson Reynolds, Sc.D., M.D., F.R.S.; Sir Henry E. Roscoe, LL.D., F.R.S.; W. J. Russell, Ph.D., F.R.S.; T. E. Thorpe, C.B., LL.D., F.R.S.; W. A. Tilden, D.Sc., F.R.S.

Vice-Presidents—J. J. Dobbie, M.A., D.Sc., F.R.S.; Rudolph Messel, Ph.D.; Sir Alexander Pedler, C.I.E., F.R.S.; W. H. Perkin, Ph.D., F.R.S.; A. Smithells, B.Sc., F.R.S.; W. P. Wynne, D.Sc., F.R.S.

Treasurer—Alexander Scott, M.A., D.Sc., F.R.S.

Secretaries—M. O. Forster, D.Sc., Ph.D., F.R.S.; A. W. Crossley, D.Sc., Ph.D.

Foreign Secretary—Horace T. Brown, LL.D., F.R.S.

Ordinary Members of Council—Edward C. C. Baly; George T. Beilby, F.R.S.; Bernard Dyer, D.Sc.; W. R. E. Hodgkinson, Ph.D.; E. Grant Hooper; H. A. D. Jowett,

D.Sc.; H. R. Le Sueur, D.Sc.; F. E. Matthews, Ph.D.; G. T. Moody, D.Sc.; A. G. Perkin, F.R.S.; W. J. Sell, D.Sc., F.R.S.; John Wade, D.Sc.

Anniversary Dinner.

The Anniversary Dinner was held at the Whitehall Rooms on Friday, March 22nd, at 7 p.m., at which a large number of Fellows and Guests were present.

The following toasts were proposed:—

By the President—"His Most Gracious Majesty the King"; "Her Majesty the Queen Alexandra, their Royal Highnesses the Prince and Princess of Wales, and the other Members of the Royal Family."

By the Right Honourable Lord Rayleigh, O.M., F.R.S., President of the Royal Society—"The Chemical Society," coupled with the name of the President.

By Sir William Ramsay, K.C.B., F.R.S., President-Elect of the Chemical Society—"Scientific Societies," coupled with the names of the Right Honourable Lord Kelvin, O.M., G.C.V.O., F.R.S., and Professor E. Ray Lankester, F.R.S., President of the British Association for the Advancement of Science.

By Prof. Henry E. Armstrong, F.R.S., Past-President of the Chemical Society—"Education," associated with the names of Mr. T. H. Warren, Vice-Chancellor of the University of Oxford; Sir Arthur W. Rücker, F.R.S., Principal of the University of London; and Sir John Wolfe Barry, K.C.B., F.R.S., Chairman of the Executive Committee of the City and Guilds of London Institute.

Prof. T. E. Thorpe, C.B., F.R.S., Past-President of the Chemical Society—"The Guests," coupled with the names of Geh. Rath Professor Dr. Emil Fischer, F.R.S., and Professor J. A. Ewing, F.R.S., Director of Naval Education.

After the President had given the Loyal Toasts, the Right Honourable Lord Rayleigh, O.M., proposed "The Chemical Society."

He said the toast would require but little commendation from him in such a company as was assembled. Although most of his time had been given up to the study of physics, he had always taken the keenest interest in their science, and at an early age had served a sort of apprenticeship to it, having managed to burn his fingers rather seriously with phosphorus before he was thirteen. Their science was so extensive and grew with such rapidity that many of its branches were but little known to him. As examples of this growth, he referred to the development of the aniline dye industry, which had become of immense theoretical and practical importance, and to the various branches so intimately connected with the name of Dr. Emil Fischer. In some aspects, chemistry might be regarded as a branch of physics, and only lately he had been looking over those wonderful papers of Willard Gibbs which were still the foundation of that branch of chemical science, and which had recently been collected and re-published.

Professor Meldola was a man of many and varied attainments. Primarily he was a chemist, but there were few departments of science with which he was not connected, and therefore in giving the toast of the Society he would couple with it the name of its President.

The President said he was deeply indebted to those present for the very kind reception which they had given to the toast proposed by the distinguished President of the Royal Society. He could not help feeling that this was one of those rare occasions that fall to the lot of the official representative of one of the scientific societies to speak to a somewhat wider public than his own immediate circle of colleagues who meet within the walls of the scientific societies, and he would take this opportunity of saying a word or two as to the work of these societies. He feared there was only too much truth in the accusation that this is an unscientific nation. Still, he would have it known that in societies like that assembled and in kindred societies there were banded together small armies of ardent workers who were keeping alight the torch of scientific research, and that, however unscientific nationally, when the time of scientific enlightenment arrived he hoped this would count to our credit and for merit. With regard to the Chemical Society in particular, he felt disposed to join issue with Lord Rayleigh as to whether chemistry should be regarded as a branch of physics or physics as a branch of chemistry. He claimed that in its ultimate association with other departments of science, chemistry was as far-reaching, as cosmopolitan, as any branch of science which was being cultivated at the present time. The Chemical Society was in an exceedingly flourishing condition. It was a venerable Society, founded in 1841, and granted a Charter in 1848. It had therefore arrived at what, according to the Civil Service estimates, would be considered as the year of dotage, instead of which he regarded it as only just entering its prime. During the last few months the Society's ranks had been thinned by the hand of death in the most lamentable way. All its honorary and foreign Russian members, Beilstein, Mendeleeff, and Menschutkin, had been lost, and in France Moissan had passed away, and, quite recently, Berthelot. He was sure those assembled would like it to be known how deeply they sympathised with their foreign *confrères* on the international loss which science had sustained by the death of these distinguished chemists. The Society had a membership of nearly 2900, and was spending from £4000 to £5000 a year in printing and publishing the *Transactions*, *Proceedings*, and *Annual Reports*. Of the value of these publications he need say nothing, for they were sufficiently well known, and if any justification for the Society's existence were ever needed its publications might be pointed out as the one great work which it had so successfully carried on. The editorial department was omnivorous. In the pages of the *Journal*, room was made for atoms and electrons, and even corpuscles. They all received perfectly impartial editorship, and if the new President would forgive the reference, space was even found for organic chemistry! Among the self-imposed duties of the President was the delivery of an Annual Address, and that afternoon he had been dealing with a subject he had closely in mind, namely, the position of chemical research in this country. He had come to the conclusion that there was an immense deal of chemical talent, of chemical faculty, but that there was an enormous wastage going on all over the country owing to unfavourable conditions, some of which he had endeavoured to analyse in the course of his Address. That was a very deplorable state of affairs, for which he saw no immediate prospect of any remedy. He thought gratitude should be expressed for any checks to this wastage that might be in existence, and that it was the duty, not only of the Chemical Society as regards its own science, but the duty of the scientific world as a whole to give recognition to those agencies which were at work, helping to check this wastage of what he and many others considered to be one of the most valuable assets possessed by the country, namely, the original faculty of scientific work. Of such agencies he would mention the 1851 Exhibition Scholarship, the Fellowship given by the Salters' Company, and the Carnegie Scholarships. As to Research funds, the Government made a grant to the Royal Society, but chemistry could only come in for its share along with other sciences. Then there was the Research Fund of the Chemical Society, from which there accrued the modest income of some £220 per annum, and on account of that income being so modest its allotment had to be limited to workers for the purchase of expensive materials and apparatus. The fund had been augmented recently by the munificence of the Goldsmiths' Company, who had added £1000 to it. He would take this public opportunity of expressing the appreciation of the whole scientific world at the munificence of this same Company, which had so splendidly endowed the Lawes Agricultural Institute by a gift of £10,000. Then it was hoped that in a short time the sum of £2700 would be added to the Research Fund of the Chemical Society in the name of a distinguished

Past-President, Sir W. H. Perkin. Much more could be done if there were greater reserves to fall back upon. It had always been a point of ambition to him to see the Research Fund in such a position as would enable the Society to give personal grants to workers, so that they could each secure the services of competent men to co-operate with them in their work. That point appealed particularly to teachers like himself. All teachers had had brilliant young men passing through their classes who had been compelled to go out into the world as soon as possible to earn their living, and thus the country had practically lost the benefit of their capabilities. If by some such endowment as that alluded to teachers were enabled to capture talent of this kind and keep it going, the chemical research of the country would be an enormous gainer in the long run.

Sir WILLIAM RAMSAY, K.C.B., proposed "Scientific Societies." After mentioning many of the learned Societies of Europe and America, he asked why were they banded together. There were important reasons. One was that the young members were enabled to meet the old, which gave great encouragement to the younger men, and their elders found pleasure in knowing them, but the chief reason was that they all had at heart the advancement of knowledge. They desired to increase the sum total of the knowledge of the phenomena of the world. Their desire to know was insatiable, and they were willing to make sacrifices to that end. In that way they founded a brotherhood with all others who were working like themselves, independent of politics and independent of nationality. For these reasons, he asked them to drink the toast.

Lord KELVIN, O.M., G.C.V.O., was the first to respond, He said he found it very difficult to distinguish between the scientific societies for which he had to reply. He believed "Physics" was the subject for which he was specially responsible. But chemistry—how was it distinguished from physics? For fifty-three years he had endeavoured to teach natural philosophy, which was Scotch for physics. and he never could distinguish between physics and chemistry. Well, what was physics and what was chemistry? He would define them together as the science of Force. They heard much at present of the breaking up of atoms, but when they heard of an object from which something had been chipped, it could not have been an atom. He had read in the newspapers of the death-bed of an atom, and yet chemists were going to be told that there was no such thing as an atom! Whether there were many atoms of a different kind was a matter for investigation, but whether each atom of its own kind remained for ever unchanged or not was a subject much discussed. He was not then going to give an opinion upon it, but it was better not to call a thing an atom when it was broken. As to chemistry, he had great sympathy with it. Lord Rayleigh burnt his fingers with phosphorus when he was thirteen. Well, he (Lord Kelvin) had burnt his fingers with phosphorus when he was eighty-two, a thing but few chemists or physicists could say.

Prof. E. RAY LANKESTER also responded. Scientific societies at the present time were somewhat limited in their objects, or at any rate in their possible activity. He thought they should become something more like the ancient guilds of the great cities of Europe, and endeavour to obtain large funds from those who had benefited and had made fortunes out of the knowledge discovered by the devotees of these sciences, and to employ those funds in development on their own particular lines. He was astonished to learn that the Chemical Society had a Research Fund that produced only £220 a year. When they heard of the large fortunes made by the application of chemistry, he felt that one reason why they did not get more was some want of organisation to enable the societies to secure a very much larger proportion of the wealth gained from the increase of scientific knowledge. In the future he thought they should try to make one large scientific society, something like a guild, or ancient college, or brotherhood, which would hold property for the benefit of a great cause. He ventured to say that would be a much better way to advance science than by gifts of money to mixed corporations, such as universities. He had no faith in universities as promoters of scientific knowledge. Judging from the use made of the funds of the University of Oxford, no one could say that it was desirable to entrust any large sum of money, at the present moment, at any rate, to that University for the promotion of scientific research. The same would apply to the University of London. But societies, such as he suggested, could apply such funds without any danger of their being perverted to secondary uses.

Prof. HENRY E. ARMSTRONG proposed the toast of "Education." Speaking of the Universities, he said a head and centre was absolutely necessary for classical activity, but they could not but feel that it was the duty of the Universities to exact from their sons also some understanding of science. Some knowledge of experimental phenomena should be aimed at in all culture.

Mr. T. H. WARREN responded first. He said that chemistry at Oxford was not what it ought to be, but its position was far different from that which it occupied some years ago. The universities were reviving the traditions of olden times. At Oxford there was a great school of chemistry, and there were many young chemists there who would be heard of before long.

Sir ARTHUR W. RÜCKER next responded. He said it was the duty of a University to teach and to add to knowledge, and he confessed to receiving a shock at what Professor Ray Lankester had said. He stoutly defended the University of London, and added that after all education was growing, and we need not despair of English education.

Sir JOHN WOLFE BARRY also responded. He said he looked forward to great results from the Colleges at South Kensington. Speaking as an engineer, he thought his profession might be stated to rest upon chemistry, which taught them the composition and properties of materials. Civil engineers were deeply indebted to the Chemical Society.

Prof. THOMAS EDWARD THORPE proposed "The Guests."

Dr. EMIL FISCHER and Prof. J. A. EWING responded.

PHYSICAL SOCIETY.

Ordinary Meeting, April 26th, 1907.

Prof. J. PERRY, F.R.S., President, in the Chair.

A PAPER on "*Electrical Conduction produced by Heating Salts*" was read by Mr. A. E. GARRETT.

The experiments described are divided into two series. The first, of a preliminary nature, consisted in testing a large number of inorganic compounds up to a temperature of 360° C. Several compounds, chiefly halogen salts, were found to produce easily detected conductivity when heated. In the case of zinc iodide, conductivity could be detected at the ordinary temperatures of the laboratory. The second series was confined to special cases in order to ascertain the causes of the increased conductivity. It was found that in all the cases tried a formula of the form $I = a\theta^{\frac{1}{2}} e^{-\frac{b}{\theta}}$; where I = saturation current, a and b constants, and θ the absolute temperature, represents with fair accuracy the connection between the saturation-current and the absolute temperature. Saturation-currents were obtained for both positive and negative ions. Moisture was found to be necessary in some cases in order that conductivity should occur; this was particularly the case with zinc iodide. The negative ions were shown to be true charged centres as they could be deflected by a magnetic field. The conductivity was stopped, when using zinc iodide, by a layer of aluminium foil 0·0008 cm. in thickness. The velocities at different temperatures and pressures were found for the positive ions produced by the iodides of zinc,

lead, bismuth, and cadmium. The positive ions from the zinc, lead, and bismuth salts move with the same velocity under the same conditions, those from cadmium move about twice as quickly. These ions seem to undergo simplification as the temperature is raised. One of these simplifications occurs at 210° C. with pressures 10 to 25 mm. of mercury. These and other considerations point to the fact that the positive ions must be charged centres loaded with considerable amounts of the products due to the chemical changes which the heated salts undergo: in fact, ions similar to those observed in recently prepared gases, phosphorus, &c. The velocities of the negative ions, from iodides of calcium, barium, and zinc, were obtained for temperature 215° C. at different pressures. The negative ions from all these compounds move with the same velocities under similar conditions of temperature and pressure. The rate of decay of zinc iodide at 25 mm. pressure and 260° C. was measured. For the first part of the heating it was found that the results could be represented by the sum of two exponential terms, but that after about one and a half hours no further decay took place.

Dr. R. S. WILLOWS expressed his interest in the paper, and said that experiments similar to the author's had recently been described by J. J. Thomson in the *Cambridge Phil. Soc. Proceedings*. In the author's experiments there was a chance of chemical decomposition, but this had been guarded against by Prof. Thomson. Electrification could also be obtained by crushing salts in a mortar.

Mr. A. RUSSELL asked if cooling salts produced any electrification.

Dr. WILLOWS said the rate of leak increased with temperature, and he should therefore expect it to be very small at low temperatures.

Mr. W. B. CROFT exhibited some Solenoids which will move under the action of the earth's magnetic field.

In showing Ampère's experiments it is not very easy to complete the theory of magnetism by making a solenoid point to the north. Many years ago Ritchie made a solenoid with an iron core, which acted as a motor with the help of a mercury commutator. A copper solenoid without core was shown which had been made to rotate in this manner. The method is unsatisfactory and uncertain, owing to the rigidity assumed by the skin on the surface of mercury in certain conditions. The Ampère mercury contacts cause no difficulty when a wire rotates on its own axis, but there are strong hindering forces when the wire is pushed through the mercury, partly from the skin and partly from amalgamation.

The best pattern for a solenoid is suggested by the moving coil of an electro-dynamometer. Two of such were shown, which were conveniently worked by four dry cells in series. Each of these was hung with very thin metal strip by bifilar suspension, the threads about 5 ins. long and one-tenth inch apart. The bifilar control makes the movements manageable: it is convenient to set the coils N. and S., or the axis of the corresponding magnets E. and W., so as to make these swing up to the meridian when a current is sent through the coils. There were also shown some wire models of magnetic lines approximately made to scale so as to represent the horizontal, vertical, and total lines of the earth.

There was also exhibited a thick copper wire of 6·28 cm. radius, which will give a unit magnetic field at the centre when ten ampères is flowing. A long magnet was hung up at the side so as to show the effect of a magnetic pole being attracted to the centre of the coil, running right through and being repelled on the other side.

The CHAIRMAN bore testimony to the great rigidity of the surface of mercury after it had been exposed to the air.

Mr. A. CAMPBELL said this difficulty could be partly overcome by covering the surface of the mercury with amalgamating solution.

Dr. CHREE believed that solenoids had been used in declinometers in Japan, but there did not appear to be any good reason for such an application.

Mr. W. S. TUCKER read a paper on "*The Influence of Pressure upon Convection Currents, and a Criticism of J. Stark's Relation between Cathode Fall of Potential and Temperature.*"

Stark employed as cathode a wire mounted radially in a globe-shaped vessel. The wire was heated electrically and its resistance and hence its temperature determined. His relation for constant temperature was employed, viz.:—

$$K = K_n + \frac{k'}{pf^{\frac{1}{2}}}(i - x'pf)^{\frac{1}{2}};$$

where K and K_n refer to total and normal cathode fall, p the pressure, i the discharge current, f the area of cathode covered with negative glow, and k' and x' are constants. His results with the heated cathode suggest the modification—

$$K = K_n + \frac{kT}{pf^{\frac{1}{2}}}\left(i - \frac{xpf}{T}\right)^{\frac{1}{2}};$$

where T is the absolute temperature of the air in the cathode dark space, supposed to be that of the cathode. He refers to the weaknesses of the method: (i) the conduction of heat away from the wire by its leads causes the observed mean temperature to be too low, (ii) the error made in assuming the cathode dark space temperature to be that of the heated cathode. The author's apparatus was devised to show how seriously these weaknesses affect Stark's results. A similar vessel having approximately the same capacity was taken and supplied with a similarly mounted wire for a cathode. Its temperature was measured at the central part of the wire only, fine potentiometer wires being connected at points well removed from the junction with the leads. Within the same vessel a fine platinum wire was mounted parallel to the cathode and about 4 mm. distant. By means of this wire the heating effects of the cathode on the air in its neighbourhood could be measured. The part played by convection currents was determined from a series of curves connecting cathode and thermometer temperatures at different pressures. It was shown that convection losses varied sufficiently both with pressure and temperature to affect the curves from which Stark derived his equation. Observations were also taken when the distance between thermometer and cathode was varied, a low pressure being used so that convection effects were small. A great diminution of temperature with distance was observed, indicating a considerable error in Stark's assumption that the cathode dark space has a temperature approximating to that of the cathode. The heating effect of a sheet cathode was examined, and the observations showed it to be more reliable than a wire. The author's curves show very different convection effects to those obtained by Prof. Bottomley, who employed a cylindrical vacuum tube. The cooling effect increases from pressures of about 15 cm. to those near 10 cm., then decreases first gradually, then rapidly. An approximate value of thermal emissivity for the bright wire was obtained which at 400° C. is near that of Schleirmacher. Reference is made to the observations of temperature in the discharge obtained by Prof. R. W. Wood, and the importance of the convection effects is suggested. Owing to convection Wood's values would probably be too high.

Mr. S. G. STARLING expressed his interest in the paper, and said the curves showing the variation in the convection currents were very valuable.

Mr. A. CAMPBELL asked if the thermometer wire employed reached its steady state gradually or whether it overshot the mark and returned gradually to it.

Mr. DUDDELL pointed out that in some of his experiments he had found that the overshoot effect was due to flow of heat along the thermometer wire. A quick working instrument would approach the steady reading gradually.

Mr. J. A. TOMKINS exhibited a Simple Apparatus for Mechanically Illustrating the Tangent and Sine Laws.

Simple apparatus for mechanically testing the tangent and sine laws were described in 1887 in Ayrton's "Practical

Electricity" and again in his more recent work published in 1897. Mr. Tomkins' apparatus, although inferior to some of Prof. Ayrton's, is extremely simple in construction and can be used equally well for illustrating the tangent or the sine law with good results. A weight is suspended by a fine thread from a hook, O. Attached to this thread at N there is a second thread passing over a pully P and terminating in a scale-pan for carrying weights. The pulley is fixed to an arm, capable of rotation about the centre C, which can be clamped in any desired position. Two scales are attached to the apparatus in such positions that the reading of one scale is proportional to the tangent of the angle made by the thread ON with the vertical, while the reading on the other is proportional to the sine of this angle. The thread ON represents the galvanometer needle, the tension in the vertical thread the controlling force, and that in the thread NP the variable deflecting force.

ROYAL INSTITUTION.

Annual Meeting, May 1st, 1907.

The DUKE OF NORTHUMBERLAND, President, in the Chair.

THE Annual Report of the Committee of Visitors for the year 1906, testifying to the continued prosperity and efficient management of the Institution, was read and adopted, and the Report on the Davy-Faraday Research Laboratory of the Royal Institution, which accompanied it, was also read.

Thirty-six new Members were elected in 1906, and sixty-three lectures and nineteen Evening Discourses were delivered.

The books and pamphlets presented amounted to about 216 volumes, making with 782 volumes (including periodicals bound) purchased by the Managers, a total of 998 volumes added to the Library in the year.

Thanks were voted to the President, Treasurer, and the Honorary Secretary, to the Committees of Managers and Visitors, and to the Professors for their valuable services to the Institution during the past year.

The Chairman announced that the Managers had awarded the Actonian Prize of One Hundred Guineas to Madame Curie, as the author of the essay "Recherches sur les Substances Radioactives."

The following gentlemen were unanimously elected as Officers for the ensuing year:—

President—The Duke of Northumberland.

Treasurer—Sir James Crichton-Browne.

Secretary—Sir William Crookes.

Managers—The Rt. Hon. Lord Alverstone, The Rt. Hon. Earl Cathcart, Sir Benjamin Baker, W. A. B. Burdett-Coutts, Dr. Donald W. C. Hood, George Matthey, The Rt. Hon. Lord Lister, Francis Elgar, Sir Andrew Noble, Bart., Henry F. Makins, Sir W. H. Perkin, Thomas Edward Thorpe, Sir William H. White, Alexander Siemens, and The Rt. Hon. Sir James Stirling.

Visitors—Arthur N. Butt, Dugald Clerk, William A. Frost, Sir John Craggs, George F. Deacon, Robert K. Gray, Edward Dent, Major E. H. Hills, Charles E. Groves, Sir John Jackson, Frederick G. Henriques, Edward Kraftmeier, Francis Lys Smith, James Swinburne, and Alfred F. Yarrow.

Royal Institution.—A General Monthly Meeting of the Members of the Royal Institution was held on the 6th instant, Sir James Crichton-Browne, Treasurer and Vice-President, in the Chair. Mr. J. H. Morrell, Dr. O. Oberländer, and Mr. F. L. Pattisson were elected Members. It was announced that His Grace the President had nominated the following Vice-Presidents for the ensuing year:—The Right Hon. Lord Alverstone, G.C.M.G., Sir Benjamin Baker, K.C.B., Dr. Ronald W. C. Hood, C.V.O., Sir Andrew Noble, K.C.B., Alexander Siemens, Esq., The Right Hon. Sir James Stirling, Sir James Crichton-Browne (Treasurer), and Sir William Crookes (Honorary Secretary).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 15, April 15, 1907.

Application to Pyridine of the Method of Direct Hydrogenation by Nickel.—Paul Sabatier and A. Mailhe. Considering pyridine, C_5H_5N, as a benzene in which one nitrogen atom of the molecule has been replaced by the group CH, the authors have applied to it the method of direct hydrogenation in contact with divided nickel, which applies readily enough to the aromatic group. The expected transformation into piperidine, $C_5H_{10}NH$, did not, however, occur. The greater part of the pyridine vapours passed unchanged over the nickel, but a slight diminution in volume was observed, most marked between 160° and 180°. The condensed liquid exhibited characteristics indicating the presence of a primary or secondary amine, and fractional distillation furnished a small quantity of this, boiling at 104°. This is also the boiling-point of piperidine, but the liquid did not correspond to the requirements for piperidine, and was proved to result from a rupture of the nucleus, giving amylamine, $CH_3.CH_2.CH_2.CH_2.CH_2.NH_2$. On heating pyridine more strongly, towards 350°, the destruction is more rapid, quantities of ammonia and of pentane being evolved. The vapours of piperidine passed over reduced nickel at 250° were found to be converted entirely into hydrogen and pyridine.

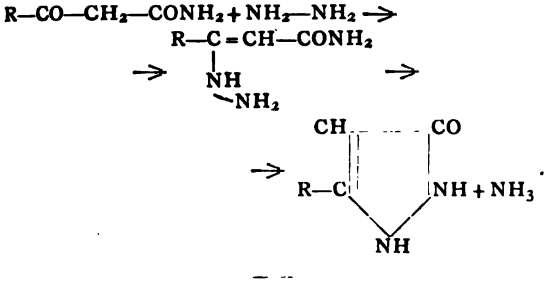
Reduction of Magnesia by Carbon.—Paul Lebeau.—Magnesium oxide is the only one of the metallic oxides not hitherto clearly shown as capable of being reduced by carbon. The author has demonstrated this reduction in the electric furnace, obtaining as the result magnesium and magnesium carbide. These products are largely destroyed by the furnace gases, which contain quantities of CO, a gas readily attacked by magnesium. The temperature at which the reduction takes place must be near the boiling-point of magnesium oxide.

Aluminium Sulphide and its Combinations with Magnesium Sulphide and with Iron Sulphide.—Marcel Houdard.—The sulphides of magnesium and aluminium are so stable that they have been found incapable of reduction in the electric furnace. This author, by heating mixtures of the two sulphides with carbon in a stream of sulphuretted hydrogen, has been able to obtain a double compound of crystalline structure, corresponding to the formula Al_2S_2Mn. Similarly, with a mixture of the sulphides of aluminium and iron, a double compound, Al_2S_4Fe, was obtained. These bodies are comparable to the aluminates.

A New Chloride of Tantalum.—C. Chabrié.—Hitherto the only known chloride of tantalum is $TaCl_5$; the new chloride corresponds to the oxide Ta_2O_2. It is prepared by reducing the pentachloride with sodium amalgam. Analysis gave the following results:—Numbers obtained—Ta, 63·83; Cl, 23·85; H_2O, 12·22; total, 99·90. Numbers calculated for formula $TaCl_2.2H_2O$—Ta, 63·1; Cl, 24·4; H_2O, 12·5; total, 100·0. *Properties.*—$TaCl_2$ is a green crystalline powder soluble in water to some extent. It turns brown in air. Heated in air, it decomposes, losing chlorine and being converted into tantalic anhydride.

Method of Synthesis of the Non-substituted β-Ketonic Amides.—Ch. Moureu and I. Lazennec.—The β-ketonic amides, R—CO—CH_2—NH_2CO, are produced from the acetylene amides by warming their alcoholic solutions with a secondary amine, preferably piperidine. In this the yield is proportional to the amount of piperidine used, for, in performing its part of catalyser, it forms an intermediate product with the acetylene amide, which then, by hydrolysis, is converted into the corre-

sponding β-ketonic amide with regeneration of the piperidine. Several of the β-ketonic amides thus produced are described. Their constitution is established from the effect produced upon them by hydrazine, which converts them into pyrazolones, with evolution of ammonia :—



Berichte der Deutschen Chemischen Gesellschaft. Vol. xl., No. 6, 1907.

Atomic Weight of Indium.—Frank Curry Mathers.—Thiel found In = 115·4 from the ratios In : $InCl_3$ and In : InI_3, but very probably this value is too high, because loss is caused owing to volatilisation when the haloids are dried; also the trichloride and triiodide may contain basic salts, and it is difficult to free indium metal from moisture and foreign salts. The mean of four results obtained in experiments in which the ratio of $InCl_3$: AgCl was determined gave 115·05, while three experiments with the corresponding bromine compounds gave 114·81. No correction was made for the solubility of silver chloride. Brauner, applying a correction for solubility, found 114·9 from the ratio $InCl_3$: AgCl. The author for the purpose of determining the atomic weight of indium purified commercial indium metal by dissolving in hydrochloric acid, precipitating off insoluble sulphides with sulphuretted hydrogen, and then precipitating the filtrate with ammonia and ammonium chloride. The hydroxides of iron, indium, and aluminium and small quantities of zinc hydroxide were thus obtained. The precipitate was washed, dissolved in hydrochloric acid, and ammonia and ammonium chloride again added; this process was repeated four times, to remove the zinc as completely as possible. Then most of the iron was removed by adding potassium rhodanide and shaking with ether, and the solution was finally electrolysed, after the free acid had been boiled off. Indium metal was thus obtained in the form of crystals. It was dried at 120°, fused in a current of hydrogen, and then used to prepare the different derivatives. Firstly, indium was converted into the sulphate by adding sulphuric acid to it in a platinum dish, and heating to 400°. However, indium sulphate is very hygroscopic, and retains traces of sulphuric acid, while if heated strongly it decomposes, and hence no accurate results were obtained. Secondly, the ratio $InCl_2$: AgCl was determined by allowing gaseous hydrochloric acid to act on the metal. As long as metallic indium was present the dark brown monochloride, InCl, was formed, but as the action of the acid continued the light yellow $InCl_2$ was produced. This was then redistilled in a current of carbon dioxide. The dichloride was dissolved in nitric acid and precipitated with silver nitrate, but very discordant results were obtained. Thirdly, the ratio $InCl_3$: AgCl was found by heating pure metallic indium in a current of chlorine. The trichloride dissolved to a clear solution in water only when some dilute nitric acid was added, probably because not all the dichloride had been converted into trichloride, and thus some metallic indium separated, $3InCl_2(+H_2O) = 2InCl_3 + In$, or possibly indium trichloride dissociates to some extent into the dichloride and chlorine. In later experiments the sublimations were carried out in a current of carbon dioxide to which some chlorine had been added. The mean of six experiments in which the atomic weight of silver was assumed to be 107·93, and that of chlorine 35·473, gave In = 114·88. The ratio $InBr_3$: AgBr was determined similarly, and as a result it was found that In = 114·86 if Br 79·953. Thus probably In = 114·9 is correct.

Ferromagnetic Compounds of Manganese with Boron, Antimony, and Phosphorus.—E. Wedekind.—The author has already shown that manganese boride is ferromagnetic, and the antimonide, MnSb, possesses the same property. Thus possibly definite chemical compounds of manganese with other elements are the carriers of the ferromagnetism, and the same components may yield magnetic and non-magnetic compounds which differ chemically in stochiometric composition. This hypothesis is supported by the fact that some compounds, for example, manganese phosphide, have been described by different investigators as magnetic and also as non-magnetic. When antimony acts on liquid manganese, only one stable compound, MnSb, can be isolated. This is more magnetic than manganese boride, MnB. Both borides, MnB and MnB_2, are ferromagnetic, but it is very difficult to separate MnB completely from MnB_2, and probably MnB_2 is non-magnetic, while the carrier of the magnetism is the compound MnB. The crystalline phosphide, Mn_5P_2, is distinctly magnetic, as is also Mn_3P_2. No phosphide, MnP, could be prepared. The investigation of the question of the degree of permeability of the ferromagnetic compounds of manganese compared with those of iron presents great difficulties, but the author found that powdered manganese boride, MnB, is more than half as strongly magnetic as powdered iron, whereas compact MnB is about a quarter as strongly magnetic as soft iron. The compact antimonide is nearly twice as strongly magnetic as MnB.

Thio-acetic Acid.—J. Houben and H. Pohl.—To prepare thio-acetic acid, $CH_3.CS.SH$, carbon disulphide is added slowly to a cooled solution of methyl magnesium iodide, which gradually turns a dark red-brown, and begins to emit a very piercing and characteristic smell. The liquid often separates into two layers. It is cooled, and first ice is added and then cooled hydrochloric acid. The red-brown ethereal layer is removed, extracted with dilute soda solution, and the solution is then extracted five or six times with ether to remove impurities of the nature of mercaptans. Ice-cold hydrochloric acid is added, and the free thio-acid taken up in ether. The acid is a reddish yellow strongly smelling oil, its odour recalling mercaptan, allyl sulphide, and acetic acid. It is practically insoluble in water. Its analysis leaves no doubt that its composition is represented by the formula $CH_3.CS.SH$, and its low boiling-point (37° under 15 mm. pressure), and other properties show that it is not a polymer of $C_2H_4S_2$. The specific gravity at 20° is 1·24. It yields neutral soluble salts with alkalis. It is a very strong acid, and replaces acetic acid in its salts. It does not ignite easily, but on warming it burns with a blue flame, yielding sulphur dioxide and carbon.

Thiosulphates.—Julius Meyer and H. Eggeling.—Two isomeric potassium sodium thiosulphates can be obtained, in one of which the sodium, and in the other the potassium, is directly bound to the sulphur. Thus the formulæ are $KS.SO_2.ONa$ and $NaS.SO_2.OK$. Exactly the same isomerism is exhibited by some double salts with heavy metals, the heavy metal being bound with the sulphur in one case and with the oxygen in the other. The silver alkali thiosulphates containing ammonia can yield yellow salts with the stronger alkalis; these are analogous to the yellow copper salts in which the copper is undoubtedly monovalent. Thus the allied elements, silver and copper, form yellow alkali double thiosulphates, as well as white salts, which are possibly isomeric, the formulæ being $AgS.SO_2.O$ and $CuS.SO_2.O$, or $AgO.SO_2S$ and $CuO.SO_2.S$. Most double thiosulphates are not stable, and only the silver and lead salts of the stronger alkalis can be kept without undergoing decomposition. Moreover, the heavy metal salts decompose if an attempt is made to re-crystallise them from water, and hence some metals can be pre-

cipitated from their hot solutions by thiosulphate solution instead of sulphuretted hydrogen.

Bismuth Iodide. — Lothar Birckenbach. — Already noticed.

Hydrolytic Decomposition of Sodium Chloride.— Fr. Emich.—A small quantity of sodium chloride is introduced into a platinum crucible raised to a yellow heat (temperature about 1100°), and then about 1 cc. of water, which is naturally at once converted into the spheroidal state. When after about half a minute half of the water has evaporated, the drops are allowed to fall into about 100 cc. of dilute blue litmus. Before the crucible has quite cooled the small quantity of fused salt which adheres to it is taken up with water, and the solution is added to dilute red litmus. The changes of colour of the litmus solutions show that the water has become acid and the salt alkaline.

MEETINGS FOR THE WEEK.

TUESDAY, 14th.—Royal Institution 3. "Alfred Stevens, the English Sculptor and Painter," by D. S. MacColl.

WEDNESDAY, 15th.—Society of Arts, 8. "Trypanosomiasis, or Sleeping Sickness," by Herbert W. G. Macleod, M.D.

—— Microscopical, 8. "Diffraction Rings due to a Circular Aperture," by A. W. Porter and P. F. Everitt. "An Improved Vertical Illuminator," by E. M. Nelson. Exhibition of Pond Life.

THURSDAY, 16th.—Royal Institution, 3. "Spectroscopic Phenomena in Stars," by H F. Newall, F.R.S., &c.

—— Chemical, 8.30. "Relation between the Crystalline Form and the Chemical Constitution of Simple Inorganic Substances, by W. Barlow and W. J. Pope. "Experimental Investigations into the Process of Dyeing," by J. Hübner. "Some Derivatives of ρ-Pyranol allied to certain Derivatives of Brazilein and Hæmatein," by W. H. Perkin, jun., and R. Robinson. "Mixed Semi-ortho-oxalic Compounds," by G. D. Lander. "The Mechanism of Bromination of Acylamino-Compounds," by J. B. Cohen.

FRIDAY, 17th.—Royal Institution, 9. "Seiches in the Lakes of Scotland," by Prof. George Chrystal, M.A., &c., assisted by E. M. Wedderburn.

SATURDAY, 18th.—Royal Institution, 3. "The Limits of the Dramatic Art," by Arthur Bourchier, M.A.

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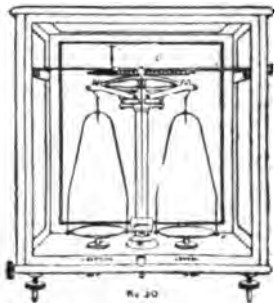

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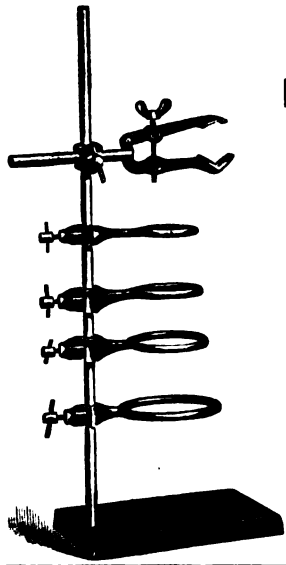

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The following experiment shows that, with care, there is practically no loss of acid :—50 cc. of water, free from carbon dioxide, were mixed with a few drops of butyric acid and neutralised with lime-water equal to 11·5 cc. of N/10 soda ; 0·5 cc. of N/10 hydrochloric acid was then added, and the liquid boiled for three minutes. One-eleventh part of the solution had evaporated. Additional lime-water, to the extent of 0·4 N/10 soda, was now required ; total, 11·9 cc. of soda, which, minus 0·5 cc. of acid added, equals 11·4 cc. The loss in acid during the boiling consequently amounted to 0·1 cc. soda.

A NEW INTERMEDIATE PRODUCT FROM THORIUM.

By OTTO HAHN.

Many articles on the properties of radio-thorium, and more especially on its relation to thorium, have recently appeared. In my first complete communication on radio-thorium (*Jahrbuch d. Radioactiv. u. Elektron*, iii., 330) I alluded to the possibility that it is a decay product of thorium, that thorium itself emits no rays, and the activity of ordinary thorium is due only to radio-thorium and its decay products. In order to signify this I chose the name radio-thorium for the strongly active product.

The articles of G. A. Blanc (*Chem. Centralblatt*, 1906, ii., 1107) and of Elster and Geitel (*Phys. Zeit.*, 1906, 445) confirmed and extended our knowledge of the radio-active properties of radio-thorium and their agreement with those of thorium, so that there can be no doubt about the identity of the two substances which emit the emanation.

Elster and Geitel succeeded in obtaining from ordinary thorium a small quantity of an oxide which was always about twelve times as strongly active as ordinary thorium oxide. They have thus effected a certain concentration of radio-thorium. Also G. A. Blanc, by the action of barium sulphate, obtained from 6 kg. of thorium nitrate a few milligrammes of a product, which was some thousand times as strong as thorium oxide and also retained its activity.

The relation of the activity of thorium minerals to the amount of thorium they contain was discussed in the articles of Boltwood (*Amer. Journ. of Science*, xxi., 409) and Dadourian (*Phys. Zeit.*, 1906, 453), who obtained exactly the same result quite independently. Both workers found that the activity of thorium minerals referred to the same amount of thorium is a constant number ; a result which shows that radio-thorium is a decay product of thorium.

Thus the relations are the same as in the case of uranium and radium, in which, from the constancy of the proportion of uranium to radium in the most different minerals, conclusions can be drawn about their genetic relationship.

The researches of Boltwood and of Dadourian were not limited to thorium minerals ; commercial thorium preparations were also investigated. It was then found that commercial thorium nitrate has less than half the activity which it should show according to the amount of thorium it contains—a very remarkable result. The two investigators used quite different methods of measurement. Boltwood compared the activity by means of the effect of the α-rays, by the method first described by McCoy (*Journ. Amer. Chem. Soc.*, xxvii., 291 ; *Amer. Journ. of Science*, xxi., 433). Dadourian used his preparations in solution, collected the active deposit resulting from the emanation on a negatively charged wire, and measured the activity thus obtained, keeping the external conditions the same. Recently, Eve (*Am. Journ. Sci.*, Dec., 1906) obtained the same results, comparing thorium minerals and commercial thorium preparations of known composition by means of the γ-rays.

Thus commercial thorium nitrate was always scarcely half as strongly active as it should be.

From these results Boltwood concluded that when thorium nitrate is prepared technically, by some means more than half the radio-thorium is separated from the thorium.

Such a possibility could not be proved directly ; but so extensive a separation would be very noteworthy when we reflect that hitherto all attempts to separate radio-thorium from thorium had either been completely unsuccessful, or, as in Elster and Geitel's experiments as well as those of G. A. Blanc, had been successful only to such an extent that there was hardly any difference in the strength of the activity from that of thorium itself.

I therefore began a systematic investigation of the

activity of commercial thorium preparations of different degrees of purity, in order to find out whether during the purification process any decrease of activity could be detected. These experiments were rendered possible for me owing to the kindness of the firm of Dr. O. Knöfler and Co., of Plötzensee, near Berlin, who placed at my disposal specimens of very different degrees of purity, for which I beg to offer them my hearty thanks.

The activity of the preparations was measured by McCoy's method (*loc. cit.*), which allows the specimens to be prepared in layers which can be made as thin as is desired and are perfectly uniform, so that under the same conditions different preparations can be directly compared with one another by means of their α-activity. Generally, the thorium preparation in question was converted into oxide, and then strongly ignited for a short time in order to convert it into the non-emanating condition. Then it was stirred with chloroform, smeared on an aluminium plate by means of a fine hair-brush, and measured with an electroscope. The aluminium plates had the same form and surface, and the quantity of substance taken amounted generally to 10 to 12 mgrms. Preliminary experiments showed that the results obtained with the same preparations under these circumstances agreed satisfactorily.

Some preparations which were measured already contained a large amount of thorium, but they were always subjected to repeated purification processes. Taking into account the somewhat varying composition of the oxides, the general result obtained was that during the purification process no gradual nor sudden decrease of the activity could be detected with certainty. Variations of the activity, it is true, were obtained, but in opposite directions, while the impure specimens were sometimes found to be weaker than the pure, calculated to the same amount of thorium. This was probably due to small quantities of alkalis, owing to which the layer became somewhat hygroscopic, and caused a rather greater absorption of the α-particles. (It must be remarked that insufficiently strongly ignited ThO_2 is also hygroscopic).

Thus the separation of radio-thorium, if it occurs at all, must have been effected when the raw thorium was prepared from monazite. I therefore investigated some preparations and liquors from the first processes of the working up of monazite, as far as I could obtain them. But the result was the same in this case also. The activity corresponded satisfactorily to the approximate amount of thorium present, and also the undissolved and insoluble residue remaining behind in the working up process showed no appreciable thorium activity after an excess of thorium-X had decayed.

All the specimens examined were fresh products, and came to me directly from the technical process. It is therefore clear that attention must be directed to the variations of activity caused by thorium-X. The measurements were therefore either taken a month after delivery, or they were repeated until equilibrium with thorium-X had ensued.

The above mentioned attempts to find in the preparation and purification of commercial thorium a point at which the separation of radio-thorium takes place, or to show a gradual decrease of activity as the purification process proceeded, have thus led to no result, and the question of the whereabouts of the missing radio-thorium remained open.

I was thus confirmed in the opinion I had previously formed, that the decay of thorium into radio-thorium does not take place directly, but that an intermediate product may exist from which radio-thorium is formed.

Various facts seem to me to point to the existence of such a substance.

According to a private communication from Boltwood, the feebly active thorium nitrate in the course of nearly two years showed no appreciable alteration of its activity. Thus a relatively long duration of life must be deduced for radio-thorium. On the other hand, I had already stated in an earlier communication that the radio-thorium preparations examined by me showed a decided decrease in their activity. In my last communication on the subject I stated that an exact series of measurements was in hand, which would give information concerning the period of decay of radio-thorium, all errors being avoided as far as possible. In order to exclude external influences, such as moisture, &c., the preparation was kept on a little glass dish, the air being excluded by means of a thin plate of mica. Unfortunately, this preparation was smashed on the journey from America, so that again new experiments had to be begun. A preparation was examined for its β-activity in fused glass tubes. Another, analogous to the above preparation, was kept on a watch-glass, which was closed air-tight with a thin mica plate. To avoid electrostatic disturbances the vessels were completely wrapped in tin-foil. The result was that again the activity of the preparations decreased. However, I cannot yet state a definite decay constant, as the decay seems to proceed far more slowly after a time than at first. The order of magnitude of the outside limit of the decay period of radio-thorium seems to be about two years, or perhaps it is still less. I shall shortly return below to the possible explanation why no single numbers could be found for the decay.

Thus the radio-thorium preparations decrease, but Boltwood's weakened thorium does not increase, or not in the same proportion as would be expected if radio-thorium was the direct derivative of thorium. A way out of the difficulty is to be found in the assumption of the existence of an intermediate product between thorium and radio-thorium, with a longer duration of life than that of radio-thorium. This would explain why the feeble thorium preparation mentioned above did not increase in proportion as the radio-thorium preparations investigated by me decreased. It need only be assumed that the thorium preparation is deficient not only in radio-thorium, but also in the intermediate product, the fresh formation of which causes the fresh formation of radio-thorium.

Also the presence of considerable thorium activity in the sediments examined by G. A. Blanc, and Elster and Geitel, can easily be explained if we assume a slower product than one the decay constant of which is less than two years.

In order to prove the possible existence of such an intermediate substance between thorium and radio-thorium, the best way was to compare with one another thorium preparations of the same strength and made in the same way, but of different age, to test whether they showed any difference in activity. The firm of O. Kn fler and Co. kindly placed at my disposal average speciments of pure thorium nitrate of different years, and also some specimens the dates of the preparation of which were accurately known.

In the investigation considerable differences of activity were found, and there was a gradual decrease of activity from the newest to the older specimens. The freshly prepared thorium nitrate showed an activity of the same order of magnitude as that of a corresponding quantity of thorianite, if the activity caused by the uranium and radium in this mineral is deducted. This result agrees with Boltwood's; he prepared thorium nitrate, and proved that its strength was of the right order of magnitude.

For some years the activity then decreases, and seems after about three years to reach a value which remains nearly constant for a fairly long time. Naturally, I had not at my disposal an unlimited choice of well defined preparations; most of the older products were the year's average specimens, which naturally gave no exact numbers. I cannot therefore give a simple curve of the activities found over a large period of time; moreover, it is not certain whether in each case exactly the same conditions were maintained in the preparation.

It is probable that the gradual decrease of the activity of freshly made thorium preparations is caused by the decay of an excess of radio-thorium due to some cause or other, and as a matter of fact the order of magnitude of the decrease is a period of about two years.

After the lowest value of the activity is reached, and has lasted for some time, a gradual increase seems to occur. Thus, some still older preparations, one of the year 1898 and an old specimen of February, 1895, seemed again to show a stronger activity, and the 1895 preparation showed a somewhat higher value than the one three years younger.

In this article I am not giving any figures, as I hope soon to be able to report comprehensively upon a greater selection of thorium preparations of different age. I am now merely indicating the values found.

In the technical preparation of thorium nitrate an intermediate product is separated which emits no α-particles. Radio-thorium itself remains with the thorium. Hence, the activity of the nitrate is of the expected order of magnitude immediately after its preparation. The period of decay, and thus the period of the formation of the intermediate product, is longer than that of radio-thorium. The activity of the fresh preparation thus decreases, because the producer of radio-thorium is lacking, and, in fact, decreases with the period of radio-thorium. If the intermediate product was completely separated, and if this had a very long duration of life, the decrease would proceed nearly to zero. But as a matter of fact the duration of life of the intermediate substance is not very great. A first approximation to its decay period seems to be about seven years. Then the intermediate substance is again gradually formed, and with it the radio-thorium. After two years a lowest value of the activity is reached, and then a gradual change occurs. The recovery of the thorium then proceeds with the slower period of the intermediate substance; when this is completely reproduced the activity is again as strong as immediately after preparation, and then remains constant. About forty years would be necessary to reach this value.

Thus from the gradual decrease of the activity of the thorium preparations the existence of an intermediate substance can be shown indirectly.

A positive proof cannot be brought forward till from older thorium preparations, or from any products of the preparation of thorium, substances free from thorium have been obtained which at first show very small activity or none at all, and which then gradually exhibit the specific thorium activity. The characteristic emanation of thorium is a safe test for this, and excludes any possibility of error.

I have arranged a great many experiments to study this point, and I have succeeded in proving directly the fresh formation of radio-thorium. I have three preparations which do not contain an appreciable amount of thorium, and which for over two months have shown a constant increase of their activity. Another small specimen was prepared in November last year, and its increase of activity shows no abatement. Only the effect of the α-particles of the latter was investigated, but some of the newer preparations were in the form of a solution, and from the solutions the increase of emanating power up to a constant amount could be proved.

As in a radio-thorium preparation, even if it was at first quite free from thorium-X, after a month no more change of power of emitting an emanation occurred; if it was examined under identical conditions, the constant increase is a direct proof of the existence of a parent of radio-thorium which differs from thorium.

The experimental results obtained by the above named investigators can be explained without any straining by the existence of this intermediate substance. Clearly they were using preparations which were already some years old, and in which the original excess of radio-thorium had quite, or nearly quite, decayed. Boltwood in his article mentioned above states values for the activity of different commercial thorium preparations which, in contrast to the remarkable constancy of the activity of the minerals, show considerable differences from one another, differences which certainly lie without the limits of error. This could be explained by a difference in the age of the preparations obtained from different sources.

The fact that Boltwood has a weak thorium preparation which for nearly two years has shown hardly any change in its activity seems to me to show that here he has a specimen which lies just at the minimum of its activity; but assuming one intermediate product, as stated above, it should be possible now to detect a slow increase.

Also the periods of decay of the radio-thorium preparations examined by me, which did not quite agree, and which were apparently gradually becoming slower, could be explained by assuming the presence of varying amounts of intermediate substance. It would then, of course, be supposed that the radio-thorium prepared by me from thorianite was not actually pure radio-thorium, but contained a considerable quantity of the intermediate substance.

I refrain from definitely choosing a name for the new substance till its nature has been more closely investigated. When this has been done the name "mesothorium" would seem to me to be appropriate.—*Berichte*, vol. xl., 1462.

PROCEEDINGS OF SOCIETIES

THE ROYAL SOCIETY.

Conversazione at Burlington House.

A well attended Conversazione was held at the Royal Society's Rooms, Burlington House, on May 8th. The following are some of the most interesting exhibits:—

Dr. F. D. Chattaway, F.R.S., showed Copper Mirrors deposited upon Glass from Aqueous Solution.—Although silver is so readily deposited upon glass from aqueous solution as a coherent metallic film that mirrors are extensively manufactured in this way, it has not hitherto been found possible thus to deposit the metal copper, which in so many other respects closely resembles silver. In the mirrors exhibited, the copper has been deposited upon the glass by reducing cupric oxide by an aqueous solution of phenyl hydrazine in presence of potassium hydroxide, which accelerates the action to a remarkable extent. The mirrors are equal in brilliancy and uniformity of surface to silver mirrors, and on account of the colour of the copper are much more beautiful.

Sir James Dewar, F.R.S. The Crookes Radiometer; Motion arrested in very high Vacua, &c.

1. Experiments showing the cessation of radiometer action in very high vacua, made by charcoal cooled in liquid hydrogen or liquid air, even when the instrument is subjected to the concentrated radiation of an electric lamp.

2. Radiometer filled with helium at atmospheric pressure, which is inactive to a charcoal liquid-air vacuum, but becomes active in a charcoal liquid-hydrogen vacuum.

Mr. W. Duddell, F.R.S., showed some Persistent Electric Oscillations.—The oscillations are produced by the method of the "musical arc." In this method a direct-current arc is shunted with a circuit consisting of a condenser and a self-induction in series. The frequency of the oscillations can be varied by altering either the capacity or the self-induction in the shunt circuit. The oscillograph records exhibited show the variations in the potential difference and current when the oscillations are produced. To obtain powerful oscillations at very high frequencies the arc may be placed in hydrogen gas as employed by Paulsen. In the apparatus shown the arc burns in coal-gas, and *no magnetic field* is used to blow out the arc. Experiments in magnetic induction, tuning, and discharge in vacuo are easily demonstrated with persistent high frequency oscillations. The persistent oscillations are of special use for energising the transmitter in wireless telegraphy, as they permit better syntony or tuning to be obtained.

The DIRECTOR OF THE IMPERIAL INSTITUTE exhibited :—

1. Igneous and Metamorphic Rocks of Northern Nigeria. —Typical specimens collected during the course of the Mineral Survey of Northern Nigeria now in progress in connection with the Imperial Institute. Gneisses and schists are widely distributed and represent the oldest rocks of the country. They constitute the main part of the Bauchi Highlands, where extensive and valuable deposits of tin ore (cassiterite) have been discovered. They also cut through the sediments of the surrounding plains. Intrusions of granite are not uncommon and are seen in the chief peaks of the Bauchi Hills. At Igbo a series of metamorphic limestones occurs intercalated with mica schists. A series of twenty specimens is shown. These have been collected by Dr. Falconer, the Principal Surveyor.

2. Tinstone from Bauchi, Northern Nigeria, and Tin smelted from it.—The deposits of cassiterite are already being worked, and the tin smelted *in situ*.

3. New or exceptional Minerals from Ceylon.—These were found during the course of the Mineral Survey of Ceylon now in progress in connection with the Imperial Institute, where the composition of these materials is being investigated.

(*a*) *Zirkelite*.—A rare mineral containing the oxides of titanium and zirconium, together with variable proportions of other oxides. Three varieties are shown: (1) containing 20 per cent of thoria and 1 per cent of uranium oxide; (2) containing 8 per cent of thoria and from 2 to 5 per cent of uranium oxide; (3) containing traces of thoria and 15 per cent of uranium oxide. The crystals, which belong to the hexagonal system, differ also in specific gravity. An account of these varieties of zirkelite will shortly be communicated to the Royal Society. In exhibiting variation in the proportions of thorium and uranium the zirkelite of Ceylon shows the same peculiarities as thorianite.

(*b*) *Baddeleyite*.—Notable as a definitely crystalline form of this mineral. Some crystals exhibit twinning, others are untwinned. The mineral is essentially oxide of zirconium.

(*c*) *Thorite*.—Notable as an anhydrous form of the mineral with the high specific gravity of 6. Essentially a silicate of thoria, containing 74 per cent of thoria.

(*d*) *Monazite*.—Consists mainly of phosphates of the cerium metals, notable in containing variable and unusually high percentages of thoria. The three specimens shown contain 10, 15, and 28 per cent of thoria respectively.

4. New Vegetable Products of hitherto unknown composition.

(*a*) Wax of the Raphia palm of Madagascar (*Raphia ruffia*), obtained from the leaves.—This consists principally of two solid aliphatic alcohols, the chemical constitution of which is at present under investigation at the Imperial Institute.

(*b*) Oil of *Origanum hirtum*, or *onites* of Cyprus.—This is found to contain cymene and carvacrol, together with a new terpene and alcohol. It has been introduced into perfumery. The oil of another thyme, *Origanum maru*, of Cyprus, closely resembles oil of marjoram. It contains terpinene, terpinenol, and a new crystalline alcohol, $C_{10}H_{17}(OH)_3$, which is at present under investigation.

(*c*) Oil obtained from the *Pimenta acris* of Mauritius. —This oil contains phellandrene and eugenol, and may be of value in perfumery.

Mr. W. A. DOUGLAS RUDGE showed the Action of Radium and other Salts on Gelatin Culture Medium.—Radium, barium, strontium, and lead salts, when placed in contact with gelatin culture medium, give rise to a kind of cellular growth, which is due to the formation of an nsoluble precipitate with the sulphuric acid usually present. Radium salt added to medium from which the sulphuric acid has been removed, causes no growth, but the addition of a soluble sulphate produces a growth at once. Analysis of the growths obtained with radium salts show that they are composed of barium sulphate.

Mr. ULRICH BEHN exhibited a short Glycerine Barometer.—This consists of an air thermometer of the old Italian type, the bulb of which is kept at zero by means of ice in a Dewar vessel. After some weeks the apparatus must be provided with a fresh supply of ice.

Dr. J. R. MILNE showed a Special Camera for the purpose of Automatically Recording the Readings of the Scale of any Instrument.—The purpose of this invention is to enable one, when using any piece of physical apparatus, which has a scale and vernier, to record whenever wished the readings of the latter. The observer effects this by simply pressing a bulb, which causes the camera to make a photograph of the scale and vernier on a small portion of its sensitive plate. The plate is then automatically moved on a step so as to present a fresh surface for the succeeding photograph. The 5 × 4 plates employed can each receive seventy records.

Messrs. PILKINGTON and GIBBS, Ltd., exhibited a Helio-Chronometer.—The helio-chronometer gives Greenwich mean time by a simple direct solar observation. It comprises devices for adjustment in latitude, longitude, level, and azimuth. It is self-correcting for the equation of time by means of a disc divided and engraved to show the month and day; the disc can be turned to indicate the current date. The underside of the disc is a cam formed to represent the equation of time plotted as a polar curve; and touching the cam is a lever carrying the upper pierced screen through which the sun can throw a spot of light on to the centre line of the lower screen, the dial being turned about the polar axis to permit this. The imaginary mean sun is therefore advanced or retarded from the apparent sun by the amount requisite to cause the instrument to indicate Greenwich mean time correct to a few seconds.

Hon. C. A. PARSONS, F.R.S., showed some Photographs of Microscopic Diamonds obtained from pure iron heated in a carbon crucible in an electric furnace and rapidly cooled. Scale, 150 diameters.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT COMPANY exhibited :—

1. Prof. Féry's self-contained Radiation Pyrometer.—The pyrometer utilises the heating effect of the "total radiation" from a hot body, focussed as an image of that body by means of a concave mirror. It differs from the already known Féry radiation pyrometer in being entirely self-contained, the image falling upon a minute bi-metallic flat spiral (Breguet spiral). This becomes partially uncoiled as its temperature rises, and a light pointer attached moves over a dial divided to give direct (Centigrade) temperature readings. There are two temperature scales, the higher being appropriate when a sector diaphragm is fixed in front of the pyrometer so as to reduce the effective aperture. Convenient means are provided for sighting and focussing the pyrometer. The instrument is shown sighted on Prof. Féry's electric furnace, with protected carbon resistance.

2. Universal Portable Electrometer, designed by Mr. C. T. R. Wilson, F.R.S.—Gold leaf instrument with very small capacity and fused quartz insulation, suitable for work on atmospheric electricity, radio-activity, &c., and self-contained, with means for standardising the readings, which are very steady even in a fairly high wind.

Dr. ROBERT KNOX and Mr. G. PEARCE showed Skiagraphy of the Human Subject; examples illustrating the advantages of Reduction in Exposure.

Advantages of Short Exposures.—Increased definition, due probably in part to reduced frequency of movement of the respiratory and circulatory organs, and in part to absence of fogging of the photographic plate, which is inseparable from long exposures. Safety of the patient on account of the shortness of exposure to the action of the rays.

Apparatus.—The instruments employed to produce skiagraphs, with exposures varying from one to seven seconds, consist of a powerful induction coil yielding a greatly intensified secondary current, worked in conjunction with an electrolytic interrupter directly from high tension electric light mains. The core of the coil consists of transformer plates. The primary is of a much larger wire than usual and has more turns. The secondary is smaller than usual. The X-ray tube is provided with a heavy anode to withstand the current. In series with the X-ray tube, a rectifier is placed to render the current uni-directional.

Messrs. JOHNSON, MATTHEY, and Co. exhibited:—

1. Apparatus of Malleable Iridium and Rhodium.—Crucibles, dishes, &c., of malleable iridium and rhodium.

2. Apparatus of Pure Transparent Vitreous Silica.—Specimens of various forms of apparatus of fused silica, manufactured by a process which produces transparent articles of a symmetry hitherto unattained. The apparatus being *transparent*, and consisting of pure silica in a thoroughly fused and homogeneous condition, fulfils purposes for which the ordinary opaque material is unsuitable. To those unacquainted with the properties of fused silica, the following may be of interest:—It does not crack on subjection to the most violent and sudden changes of temperature. It is unattacked by the volatile acids, with the exception of hydrofluoric acid. It has a melting-point approximately equal to that of platinum. It is harder than ordinary glass. Above 1000° C. it is permeable to hydrogen and certain other gases. Its coefficient of expansion is 0·00000059 per °C. (about one-seventeenth of that of platinum). Its expansion, up to 1000° C., is regular; above 1200° C. it contracts. As far as is at present known, it shows no tendency to devitrification. Its density is 2·2 (approximately).

THE THERMAL SYNDICATE, Ltd., Wallsend-on-Tyne, showed some Pure Fused Silica Ware.—The articles consist of pure silica and are manufactured by an electric furnace process at a temperature of about 2000° C. The material is highly refractory, and possesses a very low coefficient of expansion (about one-seventeenth of that of glass), and in consequence it is able to resist sudden and extreme changes of temperature without cracking. It is unaffected by practically all acids, is an excellent electric insulator, and retains its insulating properties even at high temperatures. As will be seen it is possible to produce a brilliant lustre on the surface of the material.

CHEMICAL SOCIETY.

Ordinary Meeting, April 18th, 1907.

Sir WILLIAM RAMSAY, K.C.B., F.R.S., President, in the Chair.

MESSRS. W. S. Anderson and L. R. Scammiel were formally admitted Fellows of the Society.

It was announced that the Council had appointed the following Committees for 1907-1908:—

Finance Committee—E. G. Hooper, G. T. Moody, T. E. Thorpe, W. A. Tilden, and the Officers.

House Committee—W. R. Dunstan, J. E. Reynolds, W. J. Russell, J. M. Thomson, T. E. Thorpe, W. A. Tilden, and the Officers.

Library Committee—E. C. C. Baly, B. H. Brough, F. D. Chattaway, B. Dyer, A. Harden, C. A. Keene, A. Lapworth, E. J. Mills, J. M. Thomson (Chairman), J. Voelcker, J. Wade, the Editor, and the Officers.

Publication Committee—H. E. Armstrong, E. C. C. Baly, W. R. Dunstan, R. Meldola, G. T. Morgan, W. A. Tilden, J. Wade, and the Officers.

Research Fund Committee—G. T. Beilby, W. R. Dunstan, P. F. Frankland, A. D. Hall, G. Matthey, R. Messel, H. Müller, Sir A. Pedler, W. H. Perkin, W. A. Tilden, and the Officers.

Certificates were read for the first time in favour of Messrs. Hugh Hague Copping, B.A., Cabourne, Caistor, Lincolnshire; Matthewman Dalton Cowap, 21, Alma Square, St. John's Wood, N.W.; Eugen Fischer, Ph.D., Biebrich am Rhein, Germany; Walter George Gledhill, M.A., Dersingham, Greenroyde, Halifax; John Atkinson Jennings, 61, Gleneagle Road, Streatham, S.W.; Percival George Lloyd, 15, Woodside Road, Kingston-on-Thames; Harold Pochin, B.A., 12, Chapel Street, Berkhampstead, Herts; Charles Kenneth Tinkler, B.Sc., 297, Franklin Road, Kings Norton, nr. Birmingham.

A certificate has been authorised by the Council for presentation for ballot under By-law I. (Par. 3) in favour of Mr. Thomas Kirkman Dealy, Craigmin East, Magazine Gap, Hongkong.

Of the following papers, those marked * were read:—

*76. "*The Magnetic Rotation of Hexatriene, $CH_2{:}CH{\cdot}CH{:}CH{\cdot}CH{:}CH_2$, and its Relationship to Benzene and other Aromatic Compounds, also its Refractive Power.*" By Sir WILLIAM HENRY PERKIN.

In a paper on the magnetic rotatory power of aromatic compounds (*Trans.*, 1896, lxix., 1025) the very high rotations they possess have been pointed out; the cause of this has been supposed to be due in the case of benzene to its ring formation, because the rotation of that substance is much higher than that of its isomeride dipropargyl.

This, however, became doubtful when it was found that *d*-$\Delta^{3:8(9)}$-*p*-menthadiene, which contains two unsaturated groupings in conjunction, gave abnormally high rotations, indicating the possibility that in benzene and other substances containing unsaturated groups in conjunction, the high rotations were also due to this circumstance. It was therefore desirable to examine some chain compound containing unsaturated groups in conjunction, in which there could be no influence due to ring formation. This was rendered possible by the examination of hexatriene, which contains three consecutive unsaturated groups.

Hexatriene was found to have a remarkably high rotation of 12·196. The difference in the formation of hexatriene and benzene is simply the difference of ring formation, due to the loss of 2 atoms of hydrogen. This affects the magnetic rotation by 0·982, and if that amount is subtracted from the above a value is obtained for the magnetic rotation of benzene, based on the assumption that benzene contains three unsaturated groupings; this amounts to 11·214.

This number is practically that actually found for benzene, 11·284, and appears to point to two conclusions, namely, that benzene contains three contiguous unsaturated groupings (Kekulé's formula), and, secondly, that these have substantially the same values as in open chain compounds.

It is also noticed that the values of these unsaturated groups when in conjunction considerably increase with their number.

The refractive and dispersive power of hexatriene is very high, but the numbers do not show such a close relationship to benzene as do the magnetic rotations.

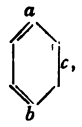
DISCUSSION.

Mr. S. S. PICKLES stated that the results obtained by Sir W. Perkin were of interest particularly to terpene chemists, who were frequently coming in contact with phenomena connected with systems of conjugated ethylenic linkings. The anomalous behaviour of compounds containing such an arrangement of double bonds called for some explanation. The fact that such compounds as phellandrene, $\Delta^{3:8(9)}$-*p*-methadiene, and $\Delta^{1:3}$-dihydrobenzene, all of which contain the grouping ·C:C·C:C·, combine with only two atoms of bromine additively, instead of with four as might be expected, and the persistence of the remaining condition of unsaturation had often led chemists to wonder what was the state of affairs in conjugated ethylenic linkings. Sir W. Perkin's determinations

had shown that from a physical standpoint there were reasons for assuming a somewhat similar condition to that prevailing in the benzene ring, and the speaker considered that the above mentioned behaviour was to some extent chemical evidence in the same direction.

Thus, accepting certain properties and behaviour as the outcome of this arrangement of double bonds, the Kekulé formula becomes applicable and explanatory in the case of benzene.

Mr. BALY pointed out that in the Kekulé benzene formula—



the conjugation of double linkings is greater than in hexatriene; in benzene this effect occurs between the double linkings *a* and *b*, between *b* and *c*, and between *c* and *a*, whilst in hexatriene, $\overset{a}{CH_2}:\overset{b}{CH}\cdot\overset{c}{CH}:CH\cdot CH:CH_2$, the effect only occurs between *a* and *b* and between *b* and *c*, and not between *c* and *a*. He asked whether this increased conjugation might not be the origin of the fact that the magnetic rotation of benzene is higher than that of hexatriene by 0·07. He did not agree with Professor Armstrong's remarks that Sir William Perkin's results do not fit in with the modern views of the benzene molecule. The three double linkings as required by the Kekulé formula give rise to a definite amount of conjugation between them, and hence to a definite magnetic rotation. If the ring be flexible and in a state of pulsation or vibration, the total amount of conjugation would remain the same, as no energy leaves or enters the system. The magnetic rotation would therefore be the same as that demanded by the three static double linkings.

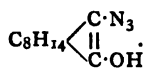
The PRESIDENT remarked that the fact that Sir William Perkin had found results which proved that the Kekulé formula for benzene is the "true" one might be interpreted as implying that the Kekulé formula is the mean of the various possible formulæ for benzene, configurations which it undoubtedly assumes during its changes.

Sir W. H. PERKIN, in reply, said that it was well to bear in mind that the difference in rotation between the chain compounds hexatriene and hexane was practically the same as that existing between the ring compounds benzene and hexamethylene. That the two classes of compounds should possess different chemical properties did not seem surprising.

The difference of 0·07 between the rotation of benzene estimated from hexatriene and the found value was small, and might partly be due to experimental error; it had therefore not been thought advisable to give any special significance to it in the meantime.

*77. "*Aromatic Azoimides.* Part I. p-*Hydroxyphenylazoimide.*" By MARTIN ONSLOW FORSTER and HANS EDUARD FIERZ.

The properties of camphorylazoimide have led the authors to investigate those of aromatic hydroxy-derivatives containing the N_3-nucleus in order to ascertain whether the behaviour of the first-named substance is not best explained by the constitutional formula—



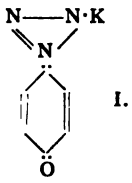
p-*Hydroxyphenylazoimide*, $HO\cdot C_6H_4\cdot N_3$, prepared by the action of hydroxylamine on diazotised *p*-aminophenol, is a colourless oil which has not been solidified, as an attempt to purify it by distillation under 1 mm. resulted in an explosion at 150°. The *benzoyl* derivative melts at 80°, and the *potassium* derivative has been obtained in two forms, coloured and colourless. The m-*nitrobenzoyl* derivative is faintly yellow, and melts at 118°.

Nitrous acid converts *p*-hydroxyphenylazoimide into 3-*nitro*-4-*hydroxyphenylazoimide*, $C_6H_4O_3N_4$, a volatile, orange-coloured compound melting at 91°; the *benzoyl* derivative is colourless, and melts at 103°.

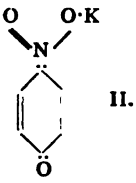
DISCUSSION.

Prof. MELDOLA asked whether the identity of the benzoyl derivatives prepared, on the one hand, by benzoylating the azoimide obtained by the author's method, and, on the other, from *p*-nitrophenyl benzoate by reduction, diazotisation, and conversion into the azoimide by the usual method, did not indicate that the compound possessed the phenolic as distinguished from the quinonoid constitution.

Dr. MORGAN inquired whether the authors recognised any analogy between the isomeric potassium derivatives of their *p*-hydroxyazoimide and the two series of ethers obtained by Hantzsch and his collaborators from the nitrophenols. If such a comparison were valid the alternative Formula I. for the coloured potassium salt :—



I.



II.

would indicate clearly the relationship existing between this salt and the coloured ether (Formula II.) of *p*-nitrophenol.

In reply to Prof. Meldola, Dr. FORSTER stated that the benzoyl derivative of *p*-hydroxyphenylazoimide obtained from *p*-nitrophenol was slightly coloured, as indeed were most of the specimens obtained from the colourless potassium derivative of the azoimide compound, but the appearance of such specimens was quite distinct from that of the benzoyl derivative obtained from the blue salt of *p*-hydroxyphenylazoimide. He regarded Dr. Morgan's suggestion as an acceptable one, and stated that the bearing of Hantzsch's work upon the problem had been appreciated in the paper.

*78. "*Measurements of the Velocities of Saponification of the* l-*Menthyl and* l-*Bornyl Esters of the Stereoisomeric Mandelic Acids.*" By ALEXANDER MCKENZIE and HERBERT BRYAN THOMPSON.

The authors find that *l*-bornyl *d*-mandelate is saponified more quickly than is *l*-bornyl *l*-mandelate. The esters were prepared from *d*- and *l*-mandelic acids respectively, and their velocities of saponification measured in ethyl-alcoholic solution under varying conditions of concentration and temperature.

l-Menthyl *d*-mandelate and *l*-menthyl *l*-mandelate (*Trans.*, 1904, lxxxv., 1249) were also examined from the same standpoint; it was found that the former ester is the more readily saponifiable of the two.

A comparison of the velocities of saponification of the bornyl and menthyl esters shows that the former are much more quickly saponified than the latter (compare also *Trans.*, 1904, lxxxv., 378; 1905, lxxxvii., 1004).

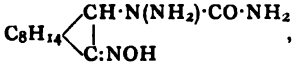
*79. "*The Constituents of the Essential Oil of American Pennyroyal. Occurrence of a Dextro-menthone.*" By MARMADUKE BARROWCLIFF.

The oil used in this investigation possessed the following characters :—$d_{15°/15°} = 0·9297$; α_D 22 +25°44′ in a 1 dcm. tube; soluble in twice its volume of 70 per cent alcohol. It has been found to consist of—(1) an undetermined phenol, in very small amount; (2) *l*-pinene (nitrosochloride, m. p. 103—104°; nitrolbenzylamine, m. p. 122°); (3) *l*-limonene (tetrabromide, m. p. 104°); (4) dipentene (tetrabromide, m. p. 124°), all of these terpenes being present in only small amount; (5) 1-methyl-3-*cyclo*hexanone (oxime, m. p. 41—43°; semicarbazone, m. p. 182—183°), about 8 per cent; (6) pulegone (semicarbazone, m. p. 171°), about 30 per cent; (7) *l*-menthone (oxime,

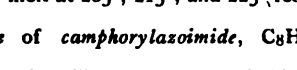
m. p. 58—59°; semicarbazone, m. p. 184—186°), and (8) *d-isomenthone* (semicarbazone, m. p. 125—126°), identical with the dextrorotatory constituent of Beckmann's "inverted menthone"; the amount of these two menthones constituting about 50 per cent of the oil; (9) a sesquiterpene alcohol, about 2 per cent; (10) esters of formic, acetic, octoic, decylic, and salicylic acids, and the ester of a dibasic acid of the probable formula $C_8H_{14}O_4$, together with formic, butyric, octoic, and decylic acids in the free state; all these esters and acids being present only in small amount.

80. "*Studies in the Camphane Series.* Part XXIII. *Oximes of Camphorylsemicarbaxide and Camphorylazoimide.*" By MARTIN ONSLOW FORSTER and HANS EDUARD FIERZ.

The *oxime* of *camphorylsemicarbaxide*,—

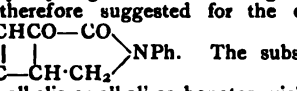


obtained from camphoryl-ψ-semicarbazide and hydroxylamine acetate, crystallises in lustrous, hexagonal plates, melts at 242°, and has $[\alpha]_D$ 105·4° in glacial acetic acid; an isomeric *oxime*, $C_{11}H_{20}O_2N_4$, produced by the action of cold dilute sulphuric acid on the foregoing substance, crystallises in lustrous needles, has $[\alpha]_D$ - 37·7° in pyridine, and melts at 222°. The *benzylidene* compound, $C_{18}H_{24}O_2N_4$, the m-*nitrobenzylidene* compound, $C_{18}H_{23}O_4N_5$, and the *furfurylidene*, compound, $C_{16}H_{22}O_3N_4$, melt at 205°, 215°, and 225°, respectively.

The *oxime* of *camphorylazoimide*,  , melts at 84°, and, unlike camphorylazoimide itself, resists the action of cold alcoholic potash; on heating with this agent, hydrazoic acid is eliminated instead of nitrogen.

81. "*The Action of Ethyl Oxalate on Thioacetanilide and its Homologues.*" By SIEGFRIED RUHEMANN.

Homologues of dithioxanthoxalanil have been obtained by the action of sodium ethoxide and ethyl oxalate on the thioaceto-derivatives of *p*-toluidine, *m*-xylidine, and β-naphthylamine respectively. With caustic potash, they behave like dithioxanthoxalanil. The action of zinc dust and acetic acid on these compounds is unlike the behaviour of the reducing agent towards xanthoxalanil and its homologues which absorb six atoms of hydrogen (Ruhemann, *Trans.*, 1906, lxxxix., 1851), and yield colourless substances, whereas dithioxanthoxalanil is transformed into $C_{20}H_{16}O_3N_2$ (grey shiny plates which decompose at about 240°). In this case, therefore, no addition of hydrogen takes place, but the whole of the sulphur is substituted by hydrogen; the following constitutional formula is therefore suggested for the compound:—



The substance, when digested with alkalis or alkali carbonates, yields blue salts of a red compound which has not yet been carefully examined, but is probably isomeric with the reduction product, $C_{20}H_{16}O_3N_2$, of dithioxanthoxalanil. This phenomenon resembles the transformation of the yellow product of the reaction between acetylacetone and phenylpropiolyl chloride into its red isomeride, which also yields blue salts (see Ruhemann and Merriman, *Trans.*, 1905, lxxxvii., 1383).

82. "*The Action of Tribromopropane on the Sodium Derivative of Ethyl Acetoacetate.*" By THOMAS EDWARD GARDNER and WILLIAM HENRY PERKIN, jun.

When tribromopropane reacts with the sodium derivative of ethyl-acetoacetate the principal product is *ethyl γ-bromoallylacetoacetate*, $CH_2{:}CBr{\cdot}CH_2{\cdot}CH(COMe)CO_2Et$, which distils at 120° (8 mm.), and, when hydrolysed with alcoholic potash, yields *Δγ-butinene-α-carboxylic acid* $CH{:}C{\cdot}CH_2{\cdot}CH_2{\cdot}CO_2H$ (m. p. 55—57°). Hydrolysis with dilute sulphuric acid converts ethyl γ-bromoallylacetoacetate into *γ-bromoallylacetone*, $CH_2{:}CBr{\cdot}CH_2{\cdot}CH_2{\cdot}COMe$, which distils at 83° (8 mm.), yields a liquid *oxime* and a crystalline *semicarbazone* (m. p. 150°), and when reduced with sodium and alcohol is converted into *2-hydroxy-5-hexene* (methylcrotonylcarbinol), $CH_2{:}CH{\cdot}CH_2{\cdot}CH(OH)Me$. Alcoholic potash hydrolyses γ-bromoallylacetone with elimination of hydrogen bromide and formation of *Δγ-butinene methyl ketone*, $CH{:}C{\cdot}CH_2{\cdot}CH_2{\cdot}COMe$. This ketone distils at 149° (749 mm.), yields an *oxime* (m. p. 48°) and a *semicarbazone* (m. p. 136°), and gives a yellow precipitate of the copper derivative when its aqueous solution is mixed with ammoniacal cuprous chloride.

The sodium derivative of ethyl methylacetoacetate reacts readily with tribromopropane, and the *ethyl methyl-γ-bromoallylacetoacetate*, $CH_2{:}CBr{\cdot}CH_2{\cdot}CMe(COMe)CO_2Et$, thus produced, yields *Δδ-pentinene-β-carboxylic acid*, $CH{:}C{\cdot}CH_2{\cdot}CHMe{\cdot}CO_2H$ (b. p. 207°), when it is hydrolysed with alcoholic potash.

Ethyl γγ-dibromodiallylacetoacetate,—

$$(CH_2{:}CBr{\cdot}CH_2)_2C(COMe){\cdot}CO_2Et,$$

is produced in small quantity when tribromopropane is digested with the sodium derivative of ethyl acetoacetate. It is a viscid oil which distils at 175—180° (8 mm.), and is hydrolysed by alcoholic potash with formation of *Δεζ-heptadi-inene-δ-carboxylic acid*, $(CH{:}C{\cdot}CH_2)_2CH{\cdot}CO_2H$. This acid melts at 48°, and is converted by boiling with water into *m*-toluic acid (compare *Proc.*, 1906, xxii., 133).

83. "*Indican.*" (Preliminary Notice). By ARTHUR GEORGE PERKIN and WILLIAM POPPLEWELL BLOXAM.

Indican, first described by Schunck (*Phil. Mag.*, 1885, [iv.], x., lxxiv., 74, and *Ibid.*, 1858, xv., 122), has recently (*Proc. K. Akad. Wetensch. Amsterdam*, 1900, ii., 520) been shown by Hoogewerff and Ter Meulen to be a well-defined crystalline substance. As the result of experience gained by a study of the process of the latter chemists, the authors have devised a comparatively simple method for the isolation of this glucoside, by which a largely increased yield of the compound is obtained. The air-dried leaves of the *Indigofera Sumatrana* are extracted with acetone, the extract partially evaporated, and diluted with light petroleum which precipitates impure indican as a syrup; this after treatment with water is filtered, and the filtrate on concentration in a vacuum deposits the glucoside in a crystalline condition. The yield approximates to about 50 per cent of that extracted by the acetone, although certain precautions are necessary. This process can be carried out entirely in the cold, and the contention of Schunck (CHEMICAL NEWS, 1900, lxxxii., 176) that his compound was distinct from the crystalline variety is thus evidently untenable. Experiments by Hoogewerff and Ter Meulen's method (*a*) and the acetone process (*b*) have shown that the leaves of *Indigofera arrecta* also contain the same indican, but in this case the preparation is more troublesome owing partly to the presence of kaempferitrin (*Proc.*, 1906, xxii., 130), but more especially to that of a colourless sugar-like compound, m. p. 186—187°, deposited in prisms from its alcoholic solution by means of ether. It resembles dulcite, but probably has the formula $C_6H_{12}O_5$ (found, C = 43·56; H = 7·44). Numerous air-dried preparations of indican melted at 57—58°, and samples obtained through the kindness of Prof. van Romburgh, of Utrecht, and Prof. Beyerinck, of Delft, had also this property, so that the m. p. 51° of Hoogewerff and Ter Meulen may be a clerical error. When dried in a vacuum, indican fuses at about 100—101°, as stated by these chemists, but this appears to be due to the presence of water, for on further heating re-solidification ensues, the product finally melting at 176—177°. Analysis of indican dried at 100° was in agreement with the formula $C_{14}H_{17}O_6N$ (H. and t. M.) (found, C = 56·83; H = 5·83), and when dried in a vacuum and allowed to regain a constant weight in moist air the figures approximated to $C_{14}H_{17}O_6N,2\frac{1}{2}H_2O$ (found, C = 49·89; H = 6·67; N = 4·38; H_2O = 13·80).

84. "*Cupric Nitrite.*" By PRAFULLA CHANDRA RAY.

A dilute solution of cupric nitrite slowly absorbs oxygen from the air, an I is converted into nitrate, following the law of mass action. When a concentrated solution of cupric nitrite, however, is evaporated over sulphuric acid, even under diminished pressure, it partially decomposes according to the equation,—

$$3Cu(NO_2)_2 = Cu(NO_3)_2 + 2CuO + 4NO.$$

The formula assigned to basic nitrite of copper by Hampe is untenable.

85. "*The Action of Hydrogen Peroxide on Potassium Cyanide.*" By ORME MASSON.

The author finds that (1) hydrogen peroxide and potassium cyanide react exothermically in aqueous solution at the ordinary temperature.

2. The peroxide is reduced without escape of oxygen so long as residual cyanide is present, but any excess of peroxide is afterwards decomposed into water and oxygen.

3. The products of the oxidation of the cyanide, which do not include oxamide or oxalate, are potassium cyanate and potassium and ammonium carbonates. Cyanate is the primary product, and tends to be converted by hydrolysis into carbonate through the catalytic agency of the peroxide.

4. A part of the cyanide is converted by hydroxysis, without oxidation, into potassium formate and ammonia.

5. The total oxidation product (cyanate plus carbonate) accounts for about four-fifths of the original cyanide, and the hydrolysis product (formate) for about one-fifth.

6. The curve representing the progress of the reduction of peroxide, so long as unchanged cyanide remains, is of the second order, and accords with the equation $\frac{dx}{dt} = k(A - x)(B - x)$, where A is the initial concentration of the peroxide, B that of the cyanide, and x the measure of the peroxide reduced, or cyanide oxidised, at time t. $B - x$ is the sum of the residual cyanide $(B - y)$, and its hydrolysed product (w).

7. The hydrolysed product (w) reaches its maximum and final value ($W = 0{\cdot}2$ B, nearly) before the completion of the oxidising action, and thereafter the slopes of the peroxide and cyanide curves are equal. The rate of hydrolysis is expressed by the empirical rule that $\frac{dw}{dt} = k_1(A - x)(W - w)$.

8. If the solutions contain at the outset the ultimate products of the action itself, as well as fresh cyanide and peroxide, these products do not exert the influence indicated by the above equations. Hence some unknown intermediate condition probably occurs while the action is in progress.

9. The addition of caustic potash or sulphuric acid at the outset greatly retards the whole action, but the addition of ammonia has very little effect.

86. "*The Reaction between Calcium Carbonate and Chlorine Water.*" By ARTHUR RICHARDSON.

The author finds that cold chlorine water decomposes calcium carbonate with formation of calcium chloride and hypochlorous acid until one part of carbonate is dissolved in thirty parts of water, as shown by Williamson, $CaCO_3 + 2Cl_2 + H_2O = CaCl_2 + 2HClO + CO_2$. At a later stage, calcium chloride, chlorate, and hypochlorite are formed, together with hypochlorous acid. This process goes on until from 40 to 50 per cent of calcium chloride is obtained; beyond this point calcium carbonate is insoluble in chlorine water.

When chlorine water containing calcium carbonate in suspension is heated, oxygen is evolved and calcium chloride and chlorate are formed. In this case also, hypochlorous acid appears to be first produced, a part being then oxidised to calcium chlorate, another part reduced to chloride, and a third part further reduced to free chlorine, whilst the hydrogen and part of the oxygen combine to form water, and the remainder of the oxygen is liberated.

87. "*The Density of Hydrogen Chloride.*" By ROBERT WHYTLAW GRAY.

Guye and Ter-Gazarian (*Comptes Rendus*, 1906, cxliii., 1233) have recently re-determined the density of this gas, and have calculated by means of it the physical atomic weight of chlorine. Some months ago the author made a series of weighings with the same object in view, but the results did not exhibit as good an agreement with each other as had been expected, and hence publication was deferred. At the request of Prof. Guye, the results of the first series of measurements are now communicated. The gas was evolved by the action of pure concentrated sulphuric acid on pure solid sodium chloride in a vacuum, and was purified by fractional distillation at a low temperature. Six experiments were made. The highest value obtained for the weight of a litre of the gas at 0° and 760 mm. in London was 1·64091 grm., and the lowest 1·64026 grm. The mean value, corrected to lat. 45, is 1·6397 grm., which is practically identical with the value 1·6398 grm. found by Prof. Guye.

88. "*Di-iodocamphor.*" By JAMES ERNEST MARSH and ROBERT DE JERSEY FLEMING STRUTHERS.

In a former paper (*Trans.*, 1905, lxxxvii., 1882), the authors stated that alkaline mercury cyanide did not form a derivative with camphor similar to that which it gives with certain other ketones. When, however, camphor is acted on by an alkaline solution of mercuric iodide containing potassium iodide, a *mercury* derivative of camphor is obtained. This substance is insoluble in water, but soluble in alcohol, and when treated with iodine gives mercuric iodide and *di-iodocamphor*. The latter substance forms brittle, yellow crystals melting at 108°, and soluble in alcohol, benzene, chloroform, or light petroleum. Its solution in chloroform is dextrorotatory. It is stable in the crystalline form, but its solution is decomposed by the action of light with separation of iodine.

89. "*Acyl-ψ-derivatives of Iminothiolcarbamic Acid and their Isomerides.*" By AUGUSTUS EDWARD DIXON and JOHN TAYLOR.

The authors have made a further study of the additive compounds produced from acylogens and thioureas, and of the migration of acyl groups within the resultant molecules (Dixon and Hawthorne, *Trans.*, 1907, xci., 122).

Ethyl chlorocarbonate unites with phenylthiourea, yielding the hydrochloride of a feeble *base*, $NH{:}C(NHPh){\cdot}S{\cdot}CO_2Et$, carbethoxylic iminophenylthiolcarbamide (otherwise, carbethoxy-ψ-phenylthiourea), which gives a *picrate*. When liberated from its hydrochloride, the base rapidly undergoes intramolecular change, the carbethoxy-radicle exchanging places with the hydrogen of the phenylamino-group, and thus furnishing the isomeric *aa*-carbethoxyphenylthiocarbamide, $CO_2Et{\cdot}NPh{\cdot}CS{\cdot}NH_2$, m. p. 133°. The hydrochlorides from *o*- and *p*-tolythioureas yield *aa*-homologues, melting at 150° and 149° respectively.

Aryl chlorocarbonates also unite with aryl-monosubstituted thioureas; the products, on withdrawal of the halogen acid, yielding *aa*-disubstituted thiocarbamides, for example, $CO_2Ph{\cdot}NPh{\cdot}CS{\cdot}NH_2$.

Toluoyl chloride unites with thiourea and with phenylthiourea; the hydrochloride,—

$$NH{:}C(NHPh){\cdot}S{\cdot}CO{\cdot}CH_2Ph,HCl,$$

m. p. 131°, gives on treatment with calcium carbonate and alcohol the compound, $CH_2Ph{\cdot}CO{\cdot}NPh{\cdot}CS{\cdot}NH_2$, m. p. 114° (corr.), isomeric with the base, when melted, it undergoes further intramolecular change into another isomeride, $CH_2Ph{\cdot}CO{\cdot}NH{\cdot}CS{\cdot}NHPh$, m. p. 110°.

Attempts to isolate *aa*-benzoylphenylthiocarbamide failed, owing to the readiness with which the *ab*-form is produced. Palmityl chloride unites with thiourea and with phenylthiourea; from the latter combination, by withdrawal of the combined hydrochloric acid, *aa*-palmitylphenylthiocarbamide may be obtained.

Phenylbenzylcarbamic chloride, $CH_2Ph{\cdot}NPh{\cdot}COCl$, does not appear to yield a hydrochloride with phenyl-

thiourea, the mixture, when warmed, decomposing with formation of benzylaniline and evolution of carbonyl sulphide.

Every *aa*-disubstituted monoacyl thiocarbamide so far examined gives thiocyanic acid when treated with strong caustic alkali; the supposed bases, $NH:C(NHPh)\cdot S\cdot CO_2Me$, &c. (Dixon, *Trans.*, 1903, lxxxiii., 550), respond to this test, and hence must be regarded as *aa*-thiocarbamides.

SOCIETY OF CHEMICAL INDUSTRY.

(LONDON SECTION).

Ordinary Meeting, May 6th, 1907.

Mr. R. J. FRISWELL in the Chair.

"*The Works Chemist as Engineer.*" By O. GUTTMANN.

All chemical works have a large number of engineering problems to solve, and as a rule the chemist will have to look after them. The author explained in detail the selection of a site, the disposition of buildings and plant, the erection of buildings to standard sizes, materials, plant, &c., in view of the products to be worked and any special risks attached to them. The installation of a power-house and the many engineering details which are of advantage in the economy and control of the production of power, smoke preventers, automatic stokers and special grates, as well as water softeners and feed-water heaters, were dealt with. The utilisation and recovery of exhaust steam, the distribution of steam over the works, and precautions in laying long pipe lines were described and exemplified on some special constructions of the author. The distribution of steam from one or more central stations and the recovery of condensed water were considered. Also the transmission of power between distant buildings was discussed, and an arrangement to drive two lines of shafting at right-angles by means of belting only was shown.

The author emphasised most strongly that "works operations were not simply laboratory operations writ large." In his opinion it was useless to teach chemical technology with the help of beakers and test-tubes.

A chemist could not be expected to do all the work that he had enumerated, because only a well trained engineer with a large experience in chemical works could attempt it. On the other hand, the works chemist ought to possess an adequate knowledge of chemical technology to enable him to understand all kinds of plant, and to confer and settle details with those who have to execute it. Only the chemist who has gained practical experience as foreman of a department, and combines therewith good engineering knowledge, can be a manager in the future. To properly train a chemist, he ought to come to college better prepared and have at least four years of study, with more mechanics and physics in the beginning and a proper course of chemical technology in the end. After that it is only necessary that manufacturers should realise that a works chemist is not solely an analyst, but a highly useful practical technologist, who, given a little confidence, will in a short time repay his salary many times over.

The paper concluded with the sentences—"We have heard too much about the many chemists engaged on research in the large colour works of Germany. Highly valuable as they are, and important as their discoveries were, the German chemical industry is infinitely more indebted to that far greater number of works chemists who patiently and thoroughly investigated the manufacturing processes, who had the ability to devise improvements and economies, and who found generous manufacturers and their college trained sons to give them their confidence. It is on these lines that we must progress."

"*Apparatus for the Estimation of Carbonic Acid.*" By HERBERT W. ROWELL.

The sample of carbonate is decomposed by a suitable acid and boiling, and the carbon dioxide collected and weighed in potash bulbs. The apparatus consists of a 70 cc. flask with a ground-glass stopper carrying a stoppered funnel for admitting acid and subsequently air, and a bulk water-vapour trap. An air-washing tube, drying tubes, potash bulbs, and a supporting stand and aspirator complete the apparatus. It is small and neat and simply worked, and the author has regularly obtained excellent results, especially with white-lead where traces of organic matter usually present render other methods valueless.

NOTICES OF BOOKS.

Practical Agricultural Chemistry. By FREDERICK D. S. ROBERTSON, F.C.S. London: Baillière, Tindall, and Cox. 1907.

A COMPLETE laboratory course of practical chemistry for agricultural students is given in this book, including the qualitative analysis of solutions containing the commoner metals and acid radicles. Separation tables are given, and the reactions of some important organic compounds are described. Gravimetric analysis and simple volumetric estimations are treated, and the more technical part of the book begins with the analysis of soils and phosphatic manures. Then feeding-stuffs, dairy products, oils and fats, sugars, tea, coffee, and cocoa, and alcoholic beverages are taken up in succession, and the book ends with the examination and analysis of water. While qualitative analysis appears to be very fully and satisfactorily treated, the part of the book devoted to the applications of chemical methods to agricultural products is marred by an indefiniteness of expression which means that the student using the book would either find it necessary to refer constantly to the teacher for fuller information, or else would waste time in gaining experience for himself by preliminary experiments. Thus, to quote only a few examples, the worker is told in the Kjeldahl-Gunning process, to boil for half-an-hour, or until all the ammonia has been driven over; but no indication is given when the latter may be assumed to have taken place, whereas the approximate measurement of the volume of the distillate is a far more satisfactory test of the complete expulsion of the ammonia even than a stated period of time. So also in the Adams coil method the coil is dried by placing it in the oven "for some time"; the flask must not be heated "too long" nor to "too high a temperature," and the temperature of distillation is not stated. The calculation of the amount of nitrogen detected by Kjeldahl's method by means of tables only, although convenient and quick, cannot be regarded as satisfactory from the students' point of view without some explanation of the way in which the figures were obtained. The neglect of such details as these must mean that either the student who uses the book is seriously hampered or the teacher is harassed by constant requests for additional information.

Science in Sugar Production. By T. H. P. HERIOT Altrincham: Norman Rodger. 1907.

THIS book is based upon a series of articles on "Simple Methods of Chemical Control" which appeared in the *International Sugar Journal*, and were much appreciated by sugar manufacturers, more especially by those whose scientific knowledge is very limited. The author's aim is to convince the old-fashioned sugar maker that it is worth his while to begin at any rate a system of partial control, which may be regarded as a step in the right direction if the employment of a skilled chemist is impossible, and with the requirements of such a manufacturer kept in view he enters into details of the simplest methods, which almost anyone could use with a fair degree of accuracy. The fitting up of a laboratory and the use of a balance are described for the novice, and directions for simple chemical

and physical processes, such as making up a solution to a given strength and finding densities, are explained. The determination of sucrose by means of a polariscope is treated more fully, the author condemning a mere rule-of-thumb knowledge of its use as quite insufficient for the sugar maker, whether he is a chemist also or not. Consequently, the somewhat difficult subject of polarisation is clearly discussed, and the construction and use of the instrument are explained from a theoretical as well as from a practical point of view. The book should fulfil its purpose satisfactorily, and the practical sugar maker will find it a useful and trustworthy guide.

Industrial Alcohol. By JOHN GEDDES M'INTOSH. London: Scott, Greenwood, and Son. Toronto: Copp Clark Co., Ltd. New York: D. Van Nostrand Co. 1907.

IN this book the production and uses of alcohol are discussed in a most comprehensive spirit, and the author shows a wide acquaintance with its manufacture and applications. Fully illustrated accounts are given of its preparation from beets, grains, potatoes, wine, and sugar-cane, and the plant necessary for distillation is described in detail. The manufacture and uses of various substances derived from alcohol, such as ether, chloroform, and amyl alcohol, are treated comparatively shortly, and two chapters deal with the use of alcohol in the arts, crafts, and industries, as well as for lighting, heating, and motive power. The author is evidently thoroughly familiar with the processes and machinery employed on the Continent, and he places at the disposal of his readers in a very convenient form a knowledge which has been acquired from all sources, while his suggestions in the direction of economy by the reduction of working expenses are well worth the attention of every distiller.

The Workmen's Compensation Act, 1906. With Notes. By W. ADDINGTON WILLIS, LL.B. (Lond.). Ninth Edition of "Willis's Workmen's Compensation Acts." London: Butterworth and Co.; Shaw and Sons. 1907.

THE Workmen's Compensation Act of 1906 is so far-reaching in its provisions that the ninth edition of this book will be welcomed by the general public, and all employers of labour should not fail to get a copy. The Act is clearly explained in it, and notes are added containing detailed accounts of all cases decided under the original acts which are equally applicable to the new statute.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 16, April 22, 1907.

Hydrogenation of Isocyanates.—Paul Sabatier and A. Mailhe.—By the method of direct hydrogenation with reduced nickel, the authors have transformed two isocyanates—one belonging to the fatty and the other to the aromatic series. 1. *Ethyl Isocyanate.*—The vapours of this body were passed over nickel with excess of hydrogen at 180—190°, and the resulting substances formed a strong aqueous solution in a cooled receptacle; by distillation the following fractionations were obtained:—(i.) A little ethylamine, boiling at 18°; (ii.) a considerable weight of methylethylamine, boiling at 35°; (iii.) a certain amount of diethylamine, boiling at 60°; (iv.) a little triethylamine, passing over at 90°. The principal reaction is therefore the normal process of hydrogenation, giving rise to methylethylamine, $C_2H_5.N:CO + 3H_2 = H_2O + NH{<}^{CH_3}_{C_2H_5}$. The presence of the other amines is explained by the fact that the water produced reacts with part of the ethyl isocyanate to give diethyl urea, $(C_2H_5.NH)_2CO$, which also undergoes hydrogenation: $(C_2H_5.NH)_2CO + 3H_2 = H_2O + C_2H_5.NH_2 + NH{<}^{CH_3}_{C_2H_5}$.

2. *Phenyl Isocyanate.*—Hydrogenation is carried out as in the preceding case, and white crystals of diphenyl urea are obtained, melting at 237°. This is produced by the action of water formed in a primary stage of the reaction:—

$$C_6H_5.N:CO + 4H_2 = C_6H_5.NH_2 + CH_4 + H_2O \rightarrow$$
$$\rightarrow 2(C_6H_5.N.CO) + H_2O = CO_2 + (C_6H_5.NH)_2CO.$$

Hence, in this case hydrogenation does not proceed in the normal manner.

A New Silicide of Tungsten, Si_2W.—Ed. Defacqz.—Hitherto only one compound of silicon and tungsten, Si_3W_2, has been isolated. The author describes the preparation of a new silicide, Si_2W. There are two methods of preparation:—1. By heating copper silicide with amorphous tungsten in the electric furnace. The resulting mass is treated with dilute nitric acid, then with dilute soda, till finally a crystalline deposit is left. 2. An intimate mixture of silica, tungstic anhydride, flowers of sulphur, and powdered aluminium is placed in a crucible, covered with powdered magnesium, and ignited according to the alumino-thermic method; after cooling, crystals of Si_2W are then produced. The analysis of this compound, which proved a delicate and difficult task, gave the following results:—

	1.	2.	3.	4.	Calculated for Si_2W.
Silicide ..	24·08	24·03	24·32	23·66	23·34
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many properties which are likely to render it of immense service both to science and to industry, *e.g.*, it can be heated white hot and plunged into water, or otherwise rapidly cooled, without any danger of cracking; it is quite unattacked by water or acids, ordinary glass under similar conditions being appreciably dissolved.

Royal Institution, Albemarle Street.—On Saturday, May 18, at 3 o'clock, Mr. Arthur Bourchier delivers the first of two lectures at the Royal Institution on "The Limits of the Dramatic Art," and on Thursday, May 23, at 3 o'clock, Professor Sir James Dewar commences a course of three lectures on "Chemical Progress—Work of Berthelot, Mendeleeff, and Moissan." The Friday Evening Discourse on May 24 will be delivered by Professor J. A. Fleming, on "Recent Contributions to Electric Wave Telegraphy"; and on May 31 by Mr. A. H. Savage Landor, on "Recent Journey Across Africa."

Osmium.—C. Paal and Conrad Amberger.—To obtain colloidal osmium preparations alkaline osmiate solutions were reduced by hydrazine hydrate in presence of protalbinic or lysalbinic acid sodium, but the reaction did not take place quantitatively, and the product was not elementary osmium, but an oxide or oxide-hydrate approximating in composition to the dioxide with 14·35 per cent of oxygen. To determine the osmium in these colloidal preparations the substance was ignited in oxygen, when the tetroxide was formed. This was collected in caustic potash containing alcohol, or in dilute alcohol, and the osmium in the solution of potassium osmiate or colloidal osmium tetroxide determined. As all known methods of determining osmium quantitatively have proved more or less inaccurate, the authors tried to estimate it by the direct precipitation of potassium or sodium osmiate solution, obtained by dissolving the tetroxide in aqueous alkali solution containing alcohol, by means of dilute sulphuric acid. This method gave accurate results. Formaldehyde reduces alcoholic solutions of osmium tetroxide to the dioxide, and alcohol reduces it to the hydroxide, $Os(OH)_4$; this colloidal reduction product begins to separate out after the liquid has stood for about five or six hours, and its formation may be hastened by warming. This method may be used for the quantitative estimation of osmium. Hydrazine hydrate reduces osmium tetroxide dissolved in alcohol to a product which contains approximately the same amount of oxygen as the compound OsO, but it is possibly a mixture of osmium with higher oxides.—*Berichte*, xl., No. 6.

MEETINGS FOR THE WEEK.

Tuesday, 21st.—Royal Institution, 3. "Alfred Stevens, the English Sculptor and Painter," by D. S. MacColl.

Thursday, 23rd.—Royal Institution, 3. "Chemical Progress—Work of Berthelot, Mendeleeff, and Moissan," by Prof. Sir James Dewar, F.R.S., &c.

Friday, 24th.—Royal Institution, 9. "Recent Contributions to Electric Wave Telegraphy," by Prof. J. A. Fleming, F.R.S.

Saturday, 25th.—Royal Institution, 3. "The Limits of the Dramatic Art," by Arthur Bourchier, M.A.

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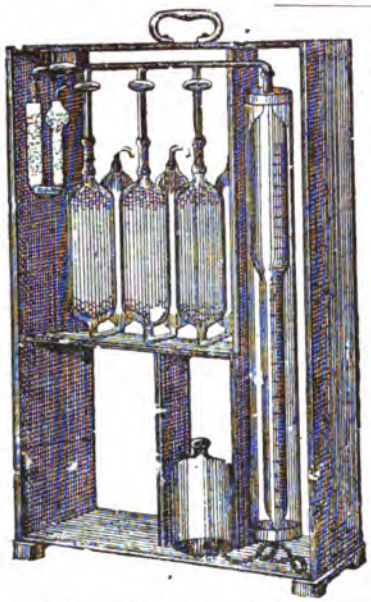

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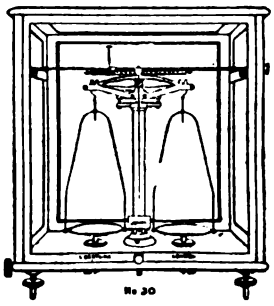

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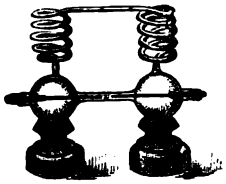

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THE CHEMICAL NEWS.

Vol. XCV., No. 2478.

REACTION BETWEEN TITANIUM TETRACHLORIDE AND ETHER.

By HENRY R. ELLIS, B.Sc.

In an attempt to prepare organic compounds of titanium by replacing the chlorine atoms of titanium tetrachloride by alkyl radicals through the agency of Grignard's reaction, it was observed that the ether used to dissolve the magnesium alkyl halide reacted with the titanium tetrachloride.

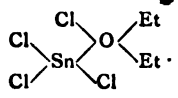
Titanium tetrachloride (45 grms.) was placed in a Wurtz flask, the side tube of which passed into a Liebig condenser connected to a receiver standing in a freezing mixture.

The flask itself was surrounded by ice. A tap funnel was inserted into the neck of the Wurtz flask, and from this pure anhydrous ether free from alcohol was allowed to drop very slowly on to the titanium tetrachloride.

The flask and its contents were shaken frequently during the reaction; as soon as the ether came in contact with the titanium tetrachloride a bright yellow crystalline solid began to separate, and continued to do so until the whole mass set solid.

About 50 cc. of ether was added before the whole of the liquid disappeared (two and a-half hours); no gas or ether passed through the condenser, and nothing collected in the receiver in the freezing mixture, although this was at a temperature of $-12°$ C.

It seems from this that the bodies produced are double compounds of $TiCl_4$ and ether, similar to the white crystalline body produced when ether is added to tin tetrachloride and which probably is an oxonium derivative—



No such body was produced when silicon tetrachloride was added to ether.

The yellow crystalline mass had the appearance of rhombic sulphur deposited from carbon bisulphide.

The substance was next warmed up on a water-bath, and became liquid at about 30° C., but on cooling solidified again, except about 2 cc. of a dark brown viscous liquid which became solid on the addition of about 2 cc. of ether; during the warming no liquid condensed in the receiver.

The solid was allowed to stand twenty hours, and was then fractionally distilled—the first fraction (3 cc.) was collected up to 34° C., and consisted of ether, hydrochloric acid gas, and a small quantity of a yellow liquid which crystallised out.

The second fraction was collected up to 60° (30 cc.), and consisted of a yellow oil which quickly solidified to yellow gem-like crystals, the thermometer quickly rose to 160° C., and about 20 cc. of a yellow liquid was collected which rapidly solidified to a mass of small yellowish white crystals. Another distillate was collected from 170° to 196° (5 cc.), and consisted of orange crystals of melting-point about 70° C.

The residue in the flask consisted of a brown powder similar in appearance to hydrated oxides of manganese.

This residue was quite insoluble in pure dry ligroin, whilst all the other bodies were becoming less soluble with increase of boiling-point. A portion of this body was washed with ligroin and dried, and the chlorine and titanium estimated; the titanium was estimated by igniting a weighed amount in a crucible after treatment with strong nitric acid, and weighing as TiO_2; the chlorine was estimated by boiling with water until all the gelatinous precipitate obtained was broken up, neutralising and titrating with N/10 $AgNO_3$. Ti = 34·4 per cent, Cl = 18 per cent.

The other substances, although they do not fume in the air, slowly decompose on standing, with evolution of hydrochloric acid gas and ethyl chloride, and have not yet been analysed.

The Chemical Laboratory,
The Polytechnic, Regent Street.

THE SO-CALLED "INFUSORIAL EARTHS" AND THEIR CHEMICAL ANALYSES.

By Prof. ARTHUR M. EDWARDS, M.D.

I believe in going to the bottom of anything when examining it. I believe in making a microscopic examination as well as a chemical examination when we examine anything. I use the microscope when I can; I use chemical analyses also.

It is interesting as well as important to compare the chemical analyses of the so-called "infusorial earths" which contain the shells of Bacillaria. They are popularly known as "diatom earths," but they are Bacillarian now. I find the records of the following:—

Hofmann (*Journ. Prakt. Chem.*, 1864) gives the analysis of the earth from Bohemia.

	1.	2.	3.	4.
Ammonia	0·03	0·01	0·34	
Potash	0·02	0·30	0·24	0·40
Soda	0·30	Trace	Trace	
Magnesia	—	0·43	0·36	0·05
Lime	0·41	0·44	0·64	Trace
Alumina, ferric oxide	0·81	5·40	5·60	0·91
Sulphuric acid	0·12	Trace	0·54	—
Phosphoric acid	0·24	Trace	Trace	0·19
Organic matter	4·20	1·30	13·20	15·45
Water	13·30	10·90	7·00	6·00
Silica	74·20	80·30	72·60	77·00
	99·63	99·08	100·52	100·00

It is from Kutschind, near Bilin, Meistersdorp, Luisa Spring, in Fransbad. No. 1 is from the upper layer, Bilin; No. 2 is from the lower layer, Bilin; No. 3 is from the Meistersdorp; and No. 4 is from Franzenbad.

These are all from "the iceberg period" geologically. No. 1 of the "tripoli," as it is called, has a density of 1·862; No. 2, of 1·944—that is to say, it is nearly twice as heavy as water.

In the "Kieselguhr zu Franzenbad" Ehrenberg discovered, in 1838, what he called *Cocconeis* (?) *clypeus*. It was afterwards, in 1841, called *Camphylodiscus clypeus*, and was also found at Santa Fiore, Italy. This also belongs to "the iceberg period." He also found in the Franzenbad deposit *Navicula bohemica* and *N. sculpta*. These are both varieties of *N. amphisbœna* of Bouy de St. Vincent, 1826. Ehrenberg calls it *N. ventricosa* (1830), and Kützing calls it *Frustulia depressa*. It is not a *Navicula*, but a *Neidium* of Pfitzer; it should be *Neidium amphisbœna*, B. de S. V.

W. Habirshaw analysed the "electro-silicon" of Virginia City, Nevada, and found it to contain—

Silica	81·08
Water, volatile at a red heat	18·44
Loss	0·48
	100·00

This belongs to the Eocene period, before the Oligocene Tertiary period. The Oligocene period is now, in this country (United States), the Neocene period or formation,

The California infusorial stratum, which was discovered by Bailey at San Pablo, near San Francisco, and near by and upon the stratum I lived nearly two years, and the Monterey and Santa Monica, is Oligocene, though ranked as Miocene by most geologists. Of course it is the Neocene period or formation now.

Cooke gives an analysis of the Drakesville, New Jersey, "infusorial stratum," which is as follows:—

Silica	80·66
Alumina	3·84
Lime	0·58
Loss on ignition (organic matter and water)	14·01
	99·09

The Drakesville deposit presumably belongs to "the iceberg period."

In Mexico, near Socorra, within 12 miles of the city, is a vast layer of infusorial earth which belongs to the Eocene period also. It seems to belong to the Occidental Sea, but has not been investigated as yet.

Now we see that the Eocene formation does not contain any alumina, and is not a clay, strictly speaking. But the iceberg period strata, both in Bohemia and in New Jersey, are clays made by the breaking down of the granite. This is the difference between those from the Eocene and the Iceberg strata, and it has been rendered solid by the solution of the silica and not by the clay.

I do not know any of them except that from Franzenbad, which has been analysed. This is also known as Soos; it contains, too, a large quantity of *Camphylodiscus*. In the Eocene period of Utah lake, and of Mono lake, and of Pyramid lake, there is present a *Surirella utahiensis* of Ehrenberg; but this is *Surirella striatula* of Turpin (1828). It is *Navicula* (?) *striatula* of Ehr., but it is a true *Surirella*. *Surirella striatula* living is brackish and marine. It is also fresh water in "Kieselguhr von Franzenbad." In fact, it sometimes occurs circular instead of elongated, and looks as if it were passing into *Camphylodiscus*. Formerly *Camphylodiscus clypeus* was known as a fossil form alone, and occurs in fresh water only. But now it is known as a brackish form in the North Sea, and there recent. It is rare in what I have called the Raised Coast period, but this is Upper Eocene as now placed, of Newark, N.J.

Dall (U.S. Geological Survey, 1892, *Bull.* No. 34, p. 117) gives an analysis by Prof. F. W. Clarke of Bailey's infusorial stratum at Ballast Point, Hillsboro County, Florida, as follows:—

Silica	70·78
Alumina and iron	11·33
Lime	2·18
Water and loss	15·71
	100·00

He says:—"An examination of this marl by Mr. Lewis Woolman, the well-known student of microscopic organisms, did not reveal a single diatom." Mr. Woolman sent me specimens of the marl, in which I also failed to observe the diatoms. Since then I have received some from Manetee, Florida, which is about 35 miles south of Tampa, Florida, and for which I am indebted to Mr. C. M. Cunningham, of Mobile, Alabama, and to Dr. W. B. Ward, of Poughkeepsie, New York, which showed Bacillaria undoubtedly, but in a fossil condition. The fossil Bacillaria, that is to say dug from the ground in distinction from those which are living (recent), are of a marine condition; that is to say, they live in the ocean, and belong to the Myocene or Oligocene tertiary period. This has been formed into the Upper Neocene period of formation now. They have not been detected on the Atlantic side of Florida, Georgia, South Carolina, or North Carolina, nor yet in Alabama, Louisiana, nor in Texas or Mexico, but we may suppose it possible: they will be found there I am sure. I am only waiting for an opportunity to visit these localities myself, for now I am convinced that the fossil Bacillaria can only be found by what is called a "diatomaniac," a person who is crazy over diatoms or Bacillaria, in which category I am proud to be known. The fossil Bacillaria of Newark, New Jersey, were found by myself, although travelled over hundreds of times by dozens of students, and I only found them when my attention was especially fixed by them and when I had time to look at them.

In the *Bulletin* of the Department of Geology of the University of California, 1893, is an article by Professor Andrew C. Lawson on the Geology of Carmelo Bay in California, wherein he speaks of the Monterey series, meaning the light coloured rocks which contain the Bacillaria, and of which I have spoken, on the Pacific coast of California. He gives the results of a chemical analysis as follows:—

Silicic oxide	86·89
Aluminium oxide	2·32
Ferric oxide	1·28
Calcium oxide	0·43
Magnesium oxide	Trace
Potassium oxide	1·26
Sodium oxide	2·32
Ignition	4·89
	99·39

But this immediate specimen contained no bacillarian remains, and it is interesting to remark that Prof. Lawson, although classifying the rocks as Miocene, says:—"The infusorial beds at Monterey appear, therefore, to be exceptional, and not representative of the series as a whole." And it is suggested that perhaps the microscopic examination of the Monterey shale will show, as a geological analysis shows, that it is of volcanic origin, and that we do not understand the geology of these rocks. I suggest the recent elevation of these rocks from the sea bottom, modified of course by volcanic agency; they then become, as they are now when microscopically examined, the same as were brought home by the *Challenger* and *Tuscarora*, as I have shown.

The analysis of the Raised Coast period clay was made by Prof. B. Silliman, and published by Prof. J. W. Bailey in a paper entitled "Notice of some New Localities of Infusoriæ, Recent and Fossil" (*Am. Journ. Sci.*, 1844, xlvii., 337). He examined the blue clay from New Haven, perhaps the same as the Quinipiac marshes, in which W. A. Terry has described diatoms (Bacillaria). Being used as a fertiliser an analysis was made. When magnified, it was found to contain particles of quartz, hornblende, and felspar, derived from the rock granite of the Green Mountains which were brought down by the glacier when it was formed, in the Glacial period; in fact, I believe these clays were formed then or antecedent thereto.

There were seen the following Bacillaria:—

Actinocyclus senarius.
Coscinodiscus excentricus.
Coscinodiscus oculus-iridus.
Cocconeis oceanica.
Dicladia (?)
Ennolia westermannī.
Galionella (*Melosira*) *sulcata.*
Grammatopha oceanica.
Pinnularia peregrina.
Pinnularia lyra.
Pinnularia didyma.

(These last three are now all Naviculas. I quote Bailey's original list).

Raphoneis rhombus.
Tessela catena.
Dictyocha speculum.
Dictyocha fibula.
Spongiolithis caput-sepertensis.

The analysis was—

Silica	58·633
Alumina	30·563
Oxide of iron	6·186
Carbonate of lime	5·263
Magnesia	0·705
	100·350

So it is an aluminium and iron silicate. When we compare the analysis of this clay with other infusorial clay, as at Richmond (Virginia), Monterey (California), &c., and with the "diatom ooze" of the Atlantic and Pacific oceans, they are found to be the same microscopically and chemically.

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

PART II.—ANALYSIS OF THE SILVER, COPPER, AND TIN GROUPS.

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 221).

Analysis of the Copper Group (continued).

Procedure 26.—To the HNO_3 solution (P. 23) add 2 to 3 cc. concentrated H_2SO_4, and evaporate in a casserole until fumes of H_2SO_4 begin to come off. Cool and pour into 10 to 15 cc. cold water, rinsing out the casserole with the same solution. Cool again, shake, and allow the mixture to stand five minutes, but not much longer. (Finely divided white precipitate, presence of *lead*; but a coarsely crystalline precipitate may be due to bismuth). Filter and wash the precipitate with H_2SO_4 (1·20), and finally with a little water. (Precipitate, P. 14, to confirm the presence of lead; filtrate, P. 27).

Notes.

1. $PbSO_4$ is somewhat soluble both in water and in concentrated H_2SO_4, but much less so in moderately dilute H_2SO_4, its solubility being scarcely appreciable in mixtures containing one volume of H_2SO_4 (1·84) and two to six volumes of water. That the solubility in dilute H_2SO_4 is less than that in water is due mainly to the common ion effect. Concentrated H_2SO_4 is, of course, an entirely different solvent. $PbSO_4$ dissolves fairly readily in dilute HNO_3 (or in dilute HCl), owing to metathesis arising mainly from the tendency to form un-ionised H_2SO_4; hence, although this effect of HNO_3 is partly counteracted by the presence of much H_2SO_4, yet, to ensure complete precipitation of $PbSO_4$, the HNO_3 must be removed by evaporation.

2. When much bismuth is present it ordinarily is dissolved at first when the water is added to the concentrated H_2SO_4, provided the mixture is kept cold; but from this solution a coarsely crystalline precipitate of an oxysulphate, such as $(BiO)_2SO_4$, separates slowly upon standing in the cold but almost immediately upon heating, and to such an extent that there may remain in solution not more than 50 mgms. of bismuth. If such a precipitate has separated with the $PbSO_4$, filter, treat the filtrate by P. 27, and dissolve the precipitate by pouring repeatedly through the filter a 5 to 10 cc. portion of HCl (1·12), and test the solution so obtained for lead by following P. 26 and P. 14.

Procedure 27.—To the H_2SO_4 solution (P. 26) add NH_4OH slowly until a strong odour of it persists after shaking. (White precipitate, possible presence of *bismuth*; blue solution, presence of *copper*). Shake to cause coagulation, filter, and wash the precipitate. (Precipitate, P. 28; filtrate, P. 29 and 30).

* From the *Technology Quarterly*, xix., No. 3, September, 1906.

Notes.

1. The precipitate produced by NH_4OH may also consist of $Fe(OH)_3$, or of other hydroxides of the iron group, if these elements were carried down in the H_2S precipitate or were not completely removed from it by washing. The formation of a small precipitate is, therefore, not a sufficient proof of the presence of bismuth, and the confirmatory tests must be applied. Antimony which, like bismuth, gives with water a precipitate of an oxychloride cannot be present in sufficient quantity to be precipitated by NH_4OH.

2. That $Cd(OH)_2$, or $Cu(OH)_2$, though only very slightly soluble in water, dissolves in NH_4OH is due to the conversion of the Cd++ or Cu++ ion in the saturated solutions into the complex cation $Cd(NH_3)_4$++ or $Cu(NH_3)_4$++, which is formed by combination of the simple ion with un-ionised ammonia. These complex cations have an extremely small ionisation tendency; thus for cadmium in a normal NH_4OH solution the ratio of the concentration of the complex to the simple ion is about 10^7. The solubility of these hydroxides in NH_4OH is greatly increased by the presence of ammonium salts, since these salts, owing to the common ion effect, greatly reduce the ionisation of the NH_4OH, and therefore the OH^- concentration in the solution, thus enabling the Cd++ or Cu++ concentration, and therefore also the corresponding complex ion concentration, to attain a much larger value than in the saturated solutions of $Cd(OH)_2$ or $Cu(OH)_2$, in NH_4OH alone. It will be noticed that four distinct equilibria are involved—that between solid $Cd(OH)_2$ or $Cu(OH)_2$ and its ions; that between Cd++ or Cu++, NH_3, and $Cd(NH_3)_2$++ or $Cu(NH_3)_4$++; that between NH_4OH, NH_3, and H_2O; and that between NH_4OH, NH_4^+, and OH^-. It may be further mentioned that, since in any dilute solution the concentration of the water is substantially constant, the concentration of any hydrate (like NH_4OH) is proportional to that of the anhydrous substance (NH_3).

Procedure 28.—Dissolve the NH_4OH precipitate (P. 27) by pouring a little HCl (1·12) through the filter, evaporate off the acid almost completely, leaving the residue only barely moist with it, add 1 to 2 cc. water, pour the solution into a flask containing 100 cc. water heated to 50—70°, and allow the mixture to stand two or three minutes. (White precipitate, presence of *bismuth*). Filter, wash once, and pour through the filter a freshly prepared solution of sodium stannite. (Black residue, presence of *bismuth*).

Notes.

1. The white precipitate formed in the first confirmatory test for bismuth is BiOCl, which is produced by the hydrolysis of $BiCl_3$. If HCl, the other product of the hydrolysis, is present in the solution, the reaction will not be complete, and a greater or less quantity of bismuth will remain in solution and thus escape detection. This quantity increases rapidly with the acid concentration in accordance with the law of mass action. For this reason, if the presence of half a milligrm. of bismuth in the precipitate is to be detected, the HCl must be removed by evaporation so completely that not more than 0·2 cc. remain, and the solution must be added to a large volume of water. Warm water is used, because the precipitation of BiOCl takes place more rapidly at the higher temperature.

2. The solution of sodium stannite (Na_2SnO_2) is prepared when needed by adding a 10 per cent NaOH solution to a 10 per cent $SnCl_2$ solution until the $Sn(OH)_2$ first formed is dissolved. The solution must be freshly prepared, because it decomposes spontaneously into sodium stannate (Na_2SnO_3) and metallic tin, and because it oxidises in contact with air to sodium stannate. SnO_2H_2 is an example of a so-called amphoteric substance—one which acts either as a base or an acid, as is shown by its solubility in both acids and alkalis.

3. The final test with sodium stannite depends on the reduction of BiOCl to black metallic bismuth. The test is an extremely delicate one, and by it may be detected a quantity of bismuth so small as to produce only a scarcely visible turbidity of BiOCl; for, when the precipitate in such a solution is collected on a filter and treated with stannite, the black colour of the bismuth is very apparent. Antimony oxychloride, even if present, is not blackened by the stannite. The NH_4OH precipitate itself might be directly tested with this reagent; for the other reducible substances, like $Fe(OH)_3$, $Pb(OH)_2$, or $Cu(OH)_2$, that might possibly be present in that precipitate are not reduced by short contact with stannite solution in the cold. It is, however, often desirable to get the double indication of the presence of bismuth, as furnished by the precipitation of the oxychloride by water and by its blackening with the sodium stannite.

Procedure 29.—Acidify one-fourth of the NH_4OH solution (P. 27) with acetic acid, add 2 to 3 drops 3 per cent $K_4Fe(CN)_6$ solution, and allow the mixture to stand for several minutes. (Red precipitate, presence of *copper*). If it is uncertain whether there is a precipitate, pour the solution through a filter and wash with a little water. (Pink colour on the filter, presence of *copper*).

Notes.

1. The confirmatory test for copper depends on the precipitation of red cupric ferrocyanide, $Cu_2Fe(CN)_6$. Since this test is a more delicate one than the formation of a blue colour with NH_4OH (P. 27), it should be tried even when the NH_4OH solution is colourless. Cadmium is also precipitated by $K_4Fe(CN)_6$; but the precipitate is white, and does not prevent the pink colour of the copper compound from being detected, provided only a small quantity of $K_4Fe(CN)_6$ is added; for the copper salt, owing to its smaller solubility, is first precipitated.

2. Nickel, like copper, gives a blue solution with excess of NH_4OH; but even if present it would give a greenish white, not a red precipitate, with $K_4Fe(CN)_6$. Aside from copper, only the rarer elements uranium and molybdenum give red precipitates with this reagent; but they do not do so in an acetic acid solution, such as is obtained in the procedure.

Procedure 30.—To the remainder of the NH_4OH solution (P. 27 and 29) add solid KCN till the blue colour disappears, and pass in H_2S gas for about half a minute. (Flocculent yellow precipitate, presence of *cadmium*). (Precipitate and solution, reject).

Notes.

1. By the addition of KCN the copper salt is reduced from the cupric to the cuprous state and then combines with the excess of KCN to form the complex salt $K+Cu(CN)_2-$ (potassium cuprocyanide). This result is due to the fact that cupric cyanide tends to decompose spontaneously into cuprous cyanide and cyanogen, and that this reaction takes place completely in KCN solution, owing to removal of the cuprous cyanide by combination with the excess of KCN. In the presence of NH_4OH the cyanogen is not evolved as a gas, but reacts with it, forming cyanate (NH_4CNO) and cyanide and other more complex products. The fact that neither CuS nor Cu_2S is precipitated from this solution by an alkaline sulphide shows that neither the $Cu++$ nor $Cu+$ concentration is sufficient to cause the value of the solubility product to be attained. The extremely small $Cu+$ concentration is due to the very slight ionisation tendency of the complex anion $Cu(CN)_2-$: thus it has been estimated that in a normal KCN solution the ratio of the concentration of the complex anion to that of the simple $Cu+$ ion is about 10^{28}.

2. The cadmium ammonia salt is also converted by KCN into a complex cyanide, namely, $K+_2Cd(CN)_4=$ (potassium cadmicyanide), since its complex anion has a much smaller ionisation tendency than the cation $Cd(NH_3)_4++$; thus in a normal KCN solution the ratio of the concentration of the complex anion to that of the simple $Cd++$ ion is about 10^{17}. Yet this complex anion is sufficiently dissociated into $Cd++$ ion to cause the solution to become saturated with CdS when an alkaline sulphide is added.

3. A very small black precipitate (which may be due to HgS or PbS) may sometimes be produced in the final test for cadmium with H_2S; but, provided the analysis has been properly conducted, not in sufficient quantity to prevent the yellow colour of 1 or 2 mgrms. of CdS from being seen. In case a black precipitate is produced, and thus prevents a positive conclusion as to the entire absence of cadmium, the precipitate may be treated, in order to eliminate the black sulphide, as follows:—Boil the precipitate for about five minutes with about 15 cc. of a mixture of one volume of H_2SO_4 (1·20) with four volumes of water, filter, cool the filtrate, add to it three times its volume of water, and pass H_2S into it for five to ten minutes. A yellow precipitate of CdS should then be obtained, if cadmium is present.

(To be continued).

THE ACTION OF SODIUM ON ACETONE.*

By RAYMOND FOSS BACON and PAUL C. FREER.

A NUMBER of years ago one of us described the action of sodium on acetone (*Am. Chem. Journ.*, 1890, xii., 355), showing that in the presence of absolute ether a *white* sodium derivative is obtained which has 30·17 per cent of sodium (calculated for sodium acetone 28·75 per cent) and which, on being added to dilute hydrochloric acid, regenerates acetone. Subsequently (*Am. Chem. Journ.*, 1891, xiii., 320), in a second discussion of the subject, it was demonstrated that hydrogen is evolved when sodium acts on acetone, and the resulting sodium derivative is again described as being *white*, but *turning red* rapidly on exposure to air and moisture. It was also shown that when this sodium derivative is added to dilute hydrochloric acid and *repeatedly extracted with ether*, no condensation products of acetone (or at least only traces) could be isolated. The sodium derivative therefore does not contain these condensation products to any great extent. The mother liquors from a number of operations in the preparation of sodium-acetone were carefully retained, united, washed with water, extracted with ether, and the residue distilled, a very small quantity of mesityloxide and some higher condensation products of acetone being isolated. Again, in another discussion of the subject (*Am. Chem. Journ.*, 1893, xv., 585; *Liebig's Ann. Chem.*, cclxxviii., 116), by acting on sodium under xylene, with acetone, 62·7 per cent of the theoretical amount of hydrogen was obtained (this observation was subsequently confirmed by Beckmann and Schleibs (*Liebig's Ann. Chem.*, 1896, cclxxxix., 86), and in the same paper, in discussing the preparation and analysis of the sodium derivative of acetone, it was shown that delay during the preparation of this derivative always resulted in increasing the percentage of sodium. A large number of samples of acetone-sodium were prepared, decomposed by dilute, ice-cold acetic acid, and united until a sufficient amount had been collected to study the reaction products; acetone (isolated as the sodium-bisulphite compound), isopropyl, and ethyl alcohols were identified among these; under favourable circumstances as much as twice the quantity of acetone as compared with isopropyl alcohol was isolated. The high-boiling fractions from the separation of the above substances gave pinacone, a small quantity of phoron, and, presumably, reduction products of the latter. *Mesityloxide could not be isolated.* A portion

* From the *Philippine Journal of Science*, ii., No. 1.

of the reaction product of sodium on acetone was found to be soluble in ether; this on careful evaporation gave a yellow powder, which oxidised in the air with remarkable readiness. (Our work shows that, under proper conditions, this residue is white.) This residue, on acidifying, separates some oil, which was isolated, and the presence of acetone was afterwards proven in the solution. The high-boiling portion of the residue was phoron. These high-boiling oils *react rapidly with phenyl hydrazine*. No isopropyl alcohol and but very little pinacone can be found among the products of decomposition of this soluble portion obtained by the action of sodium on acetone, but by far the greater part of the condensation products produced by the action of sodium on acetone are found in this residue. In proportion as such condensation products are produced, the percentage of sodium in sodium acetone will be increased.

In the *Journal of the Chemical Society*, 1906, lxxxix., 1258, Millicent Taylor has returned to the subject and comes to the remarkable conclusion that acetone-sodium "consists chiefly of caustic soda mixed with a small proportion of the sodium derivatives of alcoholic reduction and condensation products of acetone."

Apart from the fact that in her discussion Miss Taylor completely ignored the careful description given by one of us of all of the products obtained by the action of sodium on acetone, the statement which she makes that "so-called sodium acetone contains 50·4 per cent of sodium" would in itself be sufficient to cause some doubt as to the accuracy of her results. In our opinion the fact that the product of the action of sodium on acetone, when all acetone and solvent have been removed, on acidifying *regenerates acetone in large amount*, is conclusive enough evidence of the existence of sodium acetone, and this fact was repeatedly emphasised in the first series of papers on this subject, but ignored by Miss Taylor in her discussion. Nevertheless, we have deemed it necessary to repeat the work, and here it may be said that at no time, even with the absence of all of the usual precautions, were we able to encounter as much as 50 per cent of sodium in the derivative of the action of sodium on acetone; in ether we obtained 29·2 to 30·9 per cent of sodium, and the highest determination (in petroleum ether) gave us 35·5 per cent, these results being in accord with those previously obtained by one of us. In carefully reading Miss Taylor's paper it becomes evident that she always had a *red* substance present after the action of sodium on acetone, both in her experiments on the determination of the amount of sodium in the insoluble precipitate and in the soluble portion. It has in the past been expressly stated that sodium-acetone, when prepared with all precautions, is *white*, and that reddening is due to decomposition in the air or by reason of moisture.

Experimental.

Sodium acetone is a very delicate substance. When properly prepared and when air and moisture are rigidly excluded it is a *snow-white*, flocculent solid. On exposure to the air and to moisture it becomes pink, then red and brown, an oil at the same time separating, the colour changes representing the formation of sodium hydroxide and condensation products of acetone. Of course, as had previously been shown, sodium acetone also contains sodium isopropylalcoholate, and some sodium pinaconate and, in the reactions performed under ether, some sodium ethylate. All ether which we used in these experiments was repeatedly dried and distilled from sodium wire until this wire would remain perfectly bright under the solvent. The acetone was from the bisulphite compound and was dried four times over phosphorus pentoxide, each time being poured off and distilled. Dry hydrogen was run through the acetone for some hours to remove any air or carbon dioxide, and it was then kept over fused sodium sulphate and protected from moisture and carbon dioxide by tubes containing phosphorus pentoxide and soda-lime.

Experiment 1.—The apparatus used was that described by Freer (*Am. Chem. Journ.*, 1893, xv., 588). About 1·6 grms. of sodium, cut under coal oil and then washed with absolute ether, were quickly squeezed as a very fine wire into about 50 cc. of absolute ether in the reaction flask, and the apparatus quickly closed. Dry and pure hydrogen was now run through the apparatus for three hours. The reaction flask was then surrounded by ice and 10 cc. of acetone, dissolved in 50 cc. of absolute ether, gradually added through a dropping funnel. Bubbles of hydrogen were given off and the separation of a white, gelatinous precipitate soon commenced. When all of the sodium had disappeared, the ether and precipitate were sucked into a filtering tube, the latter washed eight times with absolute ether, using 50 cc. each time and always sucking as dry as possible. The precipitate was then dried to constant weight in a current of hydrogen, weighed, and decomposed with dilute, ice-cold sulphuric acid. Only a minimal amount of acetone-condensation products was obtained, as the sodium salt was practically completely soluble in water. In no instance, if the sodium derivative had been properly prepared, was there more than a drop or two of insoluble oil. When small amounts of air or moisture gain access to the sodium derivative, or when the decomposition by acids is not carefully conducted, then these condensation products result, the greater the decomposition, the greater their amount.

2·65 grms. pure white sodium acetone were obtained, containing 0·8052 grm. sodium.

	Required for C_3H_5ONa.	Found.
Sodium (per cent).. ..	28·75	30·3

The acid solution resulting from the decomposition of the product of the action of sodium on acetone was now rendered alkaline with ammonia, and iodine, dissolved in ammonium iodide, added until the colour of iodine no longer disappeared. There resulted 6·5 grms. of iodoform, equal to 1 grm. acetone or 53 per cent of the amount calculated for pure sodium acetone. Undoubtedly, some loss of iodoform occurs in evaporating its ethereal solution, and all acetone is not converted into iodoform, so that the percentage of acetone is probably really higher than given above.

(Note.—We have once more tested this method of determining acetone in the presence of isopropyl or ethyl alcohol, and can substantiate the former statements of Freer that it is sufficiently accurate for the work in hand, the results being *under* rather than over the amount of acetone. Denigés' very convenient method of acetone determination is unsuitable, as both isopropyl alcohol and mesityloxide give precipitates with his reagent. Denigés, *Comptes Rendus*, 1898, cxxvii., 963; *Ann. Chim. Phys.*, 1899, [7], xviii., 400; *Bull. de la Soc. Chim.*, 1899, [3], xxi., 241. Oppenheimer, *Ber.*, 1899, xxxii., 986; *Chem. Centrbl.*, 1899, [2], 888).

Experiment 2.—About 1·5 grms. sodium wire were dissolved in an excess of acetone diluted with absolute ether, the whole being in an Erlenmeyer flask having a very small neck. The flask was not surrounded by ice, the heat generated by the reaction evidently volatilising enough ether, to exclude air, the sodium derivative remaining white. The sodium compound was now rapidly filtered on a Hirsch funnel with strong suction, quickly washed six times with ether and then dried in a vacuum desiccator over sulphuric acid and paraffin. The salt was somewhat pink, but as soon as it was dry it was weighed to a tenth of a grm. as quickly as possible and then thrown into ice-cold, dilute acid. The acid was now saturated with potassium carbonate and the low-boiling portion distilled on a water-bath. The distillate was saturated with a solution of sodium bisulphite and the whole cooled in ice for one hour. The acetone sodium-bisulphite (4·5 grms. from 3·8 grms. sodium compound) was filtered and decomposed with sodium carbonate, the acetone being distilled. There resulted 1 grm. of acetone boiling at 54° to 57.

Experiment 3.—This was carried out exactly as was Experiment 2, with the difference that a sodium determina-

tion was made by using an excess of standard acid (found 30·9 per cent). This experiment gave 4·2 grms. of iodoform, corresponding to somewhat less than one-half the theoretical yield of acetone for pure sodium acetone.

As will be seen, even in the above two experiments, when air was not rigidly excluded and where the sodium derivative was not handled with particular care, no such high percentage of sodium as that obtained by Miss Taylor was found. Indeed, in a long series of experiments we have never been able to obtain her results, which could only be accounted for by a profound decomposition of her sodium derivative and the washing out of the acetone-condensation products which would be formed. If this decomposition were allowed to go far enough, then practically nothing but sodium hydroxide mixed with the sodium derivatives of alcoholic reduction products would remain.

Experiment 4.—This was performed as was Experiment 1, with the exception that petroleum ether was substituted as a solvent. The reaction in this case is not so clean cut as with ether, the resulting compound is somewhat pink, and the sodium percentage higher.

1·745 grms. of the sodium derivative gave 0·6203 grm. Na and 3·4 grms. iodoform, equivalent to 35·5 per cent sodium and 0·52 grm. acetone, 41 per cent respectively.

Experiment 5.—The apparatus was the same as in Experiment 1. 8·515 grms. of the sodium compound was obtained, giving 2·567 grms. of sodium, equivalent to 30·14 per cent. After the sodium salt had been decomposed, the acid solution was divided into four parts. One of these was saturated with sodium acetate, then made very slightly alkaline, and the theoretical quantity of semicarbazide hydrochloride was added. A precipitate of crystalline needles rapidly formed. After the mixture had stood for twelve hours in the ice-chest the precipitate was filtered, and it gave 1·2 grms. of acetone semicarbazone, melting-point 186°. This was identical in all respects with a specimen of the same body prepared for comparative purposes. One-eighth of the original acidified solution gave 1·3 grms. of iodoform.

Experiment 6.—The conditions were the same as in Experiment 1. 8·25 grms. of sodium derivative were obtained; from one-half of this, acidified, &c., 2·9 grms. acetone semicarbazone, melting at 186°, were separated, and from one-quarter, 2·2 grms. iodoform were precipitated. One other sodium determination gave us 29·2 per cent of sodium.

The above experiments render it practically certain that a sodium derivative of acetone exists among the products of the action of sodium on acetone, as acetone is obtained by their decomposition with acids. However, it might possibly be true that the reaction product is sodium isopropylate together with some caustic soda, and that the acetone which is found is held by the sodium isopropylate in a combination somewhat similar to alcohol of crystallisation. That this is unlikely is proved by the fact that the sodium derivative formed by the action of sodium on acetone, after filtering and washing, was dried *in vacuo* to constant weight, while at the same time it was *warmed* to beginning decomposition. If acetone were present in a condition such as the above, it certainly would be driven off by this treatment; nevertheless, the sodium derivative behaved as usual when it was added to dilute acid. That sodium isopropylate does not behave as does sodium acetone, even when it is mixed with acetone, is shown by the next experiment.

Experiment 7.—2·5 grms of sodium were dissolved in an excess of isopropyl alcohol, and diluted with absolute ether. The white colour did not change in the least when the derivative was allowed to stand for three hours in an open beaker, whereas the pro luct of the action of sodium on acetone, placed beside it under the same conditions, decomposed and completely changed in five minutes. When acetone was added to sodium isopropylate under ether, the resulting mixture remained unchanged for a long time when exposed to the air, although after one hour it had assumed a slightly pink tinge. It was now filtered, washed three times with absolute ether, dried, and thrown into dilute sulphuric acid. The usual acetone test gave no trace of iodoform. Acetone is therefore not retained by sodium isopropylate.

Miss Taylor suggests that the reaction first observed by one of us may be due to the formation of the sodium salt of diacetone alcohol, $(CH_3)_2.COH.CH_2.CO.CH_3$. This compound is formed from acetone in the cold under the influence of hydroxyl ions. Koelichen (*Zeit. Phys. Chem.*, 1900, xxxiii., 129; Heintz, *Liebig's Ann. Chem.*, 1873, clxix., 114) has shown that in the presence of hydroxyl ions there is an equilibrium between the amounts of acetone and of diacetone alcohol; thus with a concentration of hydroxyl ions represented by a 10 per cent solution of sodium hydroxide, the quantity of diacetone alcohol is 3 per cent of the total acetone, and smaller in quantity for a lower concentration of the ions. The sodium compound of this body would contain 14·37 per cent of sodium. We have prepared diacetone alcohol according to the method of Koelichen, and subjected it to the action of sodium. The alcohol was diluted with absolute ether, and in an open beaker dissolved sodium very rapidly, with marked reddening of the resulting compound, the action resembling closely that observed when acetone is similarly treated in the open air, but on acidifying the product, mesityl oxide and other condensation products of acetone are separated, and acetone could be demonstrated in the solution by the formation of its semicarbazone, melting at 185° to 186°.

A different result is obtained in an atmosphere of dry hydrogen. In the apparatus used in Experiment 1, and under absolute ether, diacetone alcohol is only very slowly attacked by sodium, giving a yellowish sodium derivative. Over four hours were consumed in dissolving 0·5 grm. of sodium in 5·5 grms. of the alcohol. The precipitate was filtered, dried in a current of hydrogen, and dissolved in dilute acid, a considerable quantity of condensation products of acetone separating. 0·74 grm. of the sodium derivative gave 1·067 grm. sodium sulphate, or 46·8 per cent sodium. It seems evident, therefore, that sodium acting on diacetone alcohol, really does give sodium hydroxide and the condensation products of acetone; the reaction is, however, so radically different from the action of sodium on acetone, and the condensation products so prominent (there are scarcely any when pure sodium acetone is dissolved in dilute acids) that the theory that diacetone alcohol is first formed, subsequently to be acted on by sodium, must be abandoned. There remains only the question, then, of whether sodium acetone could not react with acetone to give the sodium derivative of diacetone alcohol, although in this event the percentage of sodium found should be very much less than it really is. However, apart from this, in the absence of condensation products of acetone on acidifying, it must be presumed, to account for the acetone which is always found in the acidified solutions of sodium acetone, that the diacetone alcohol would promptly be re-converted into acetone during this process. Rigidly to exclude this supposition we performed the following experiment.

To be continued)

Decahydro-α-naphthylacetone and Decahydro-α-naphthylamine.—Henri Leroux.—When α-naphthol is hydrogenated by the catalytic method with nickel, decahydro-α-naphthol is produced. When oxidised with chromic acid this yields decahydro-α-naphthylacetone, which possesses the general properties of acetones. The reduction of its oxime by sodium in presence of absolute alcohol yields decahydro-α-naphthylamine, which is a very energetic base, forming well-defined salts with acids. —*Comptes Rendus*, cxliv., No. 18.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, May 2nd, 1907.

Sir William Ramsay, K.C.B., F.R.S., President, in the Chair.

Mr. A. V. Hussey was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Owen Aubrey Elias, 123, Waller Road, New Cross, S.E.; Walter Harold Nuttall, 55, Market Street, Watford, Herts; Walter Ormston Young, Springfield, Cartmel, Lancs.; Israel Hyman Zortman, B.Sc., Sternwartenstr. 44 II. r, Leipzig.

A ballot for the election of Fellows was held, and the following were subsequently declared duly elected:—John Campbell Allan; Francis James Bailey; William Robert Ball, B.Sc.; Kenneth Somerville Caldwell, B.Sc., Ph.D.; Alexander Thomas Cameron, M.A., B.Sc.; John Arthur Cunningham, B.A.; Thomas Kirkman Dealy; Samuel Duckworth, B.Sc.; John Jacob Fox; Charles Stanley Gibson, B.A.; Joshua Craven Gregory, B.Sc.; Joseph Henry Hall, B.Sc.; Arthur George Harrington; Thomas Featherstone Harvey; Geoffrey Doddleston Hope, B.Sc., Ph.D.; Edward Houghton; Hon. Raymond Egerton Hubbard; Herbert Brooke Perren Humphries, B.Sc.; Carl Lewis; James McConnan, M.Sc., Ph.D.; Herbert Victor Mitchell; Percy Joseph Rhodes; Frederic William Rixon, M.Sc., Ph.D.; John Robinson; Sydney William Smith, B.Sc.; George Colleymore Sturrock, Capt. R.A.; Sam Mortimer Sutcliffe; Nicholas Tarr; William Scott Tebb, M.A., M.D.; William Griffiths Tonner, B.Sc.

Of the following papers, those marked * were read:—

*90. "*The Chemical Action of the Radium Emanation. Part I. Action on Distilled Water.*" By Sir William Ramsay, K.C.B.

A qualitative confirmation of the fact noticed by Rutherford that the emanation from radium, in decaying, evolves a large amount of heat has been obtained; the relative amounts of hydrogen and oxygen produced by the action of radium bromide on water amounting to 32 cc. of explosive gases per grm. of radium per one hundred hours, have been measured, and also the excess of hydrogen, of which the mean value is 5·5 per cent, reckoned on the total gas. Reasons were adduced to show that hydrogen is not one of the products of degradation of radium, and other hypotheses to account for the excess of hydrogen were considered.

The action of the emanation alone on water also decomposes it into explosive gas, mixed with excess of hydrogen; it has been shown that the emanation, when mixed with explosive gas, causes re-combination, and the rate at which the decomposition of water takes place has been measured.

The reason of the production of excess of hydrogen has not yet been elucidated.

Discussion.

Prof. Tilden said that although the subject which had been brought before them by the President would probably not admit of much discussion, they would be ready to unite in expressing their admiration of the remarkable skill which had been displayed in the manipulation and measurement of such strange material in quantities so minute. They must also commend the self-restraint which Sir William Ramsay had imposed on himself in refraining from speculation in a field which offered so much temptation and where there was room for so much difference of opinion.

The President, in answer to a question, replied that the emanation was an inactive gas, in the sense of not orming compounds, but at the same time, a most active gas, inasmuch as it decomposes or disintegrates into a series of other bodies, some of which, at least, are capable of chemical combination.

*91. "*Freezing-point Curves of the Menthyl Mandelates.*" By Alexander Findlay and Evelyn Marion Hickmans.

From a study of the freezing-point curve for mixtures of *l*-menthyl *l*-mandelate and *l*-menthyl *d*-mandelate, it is found that *l*-menthyl *r*-mandelate exists as a definite, partially racemic compound having a stable melting-point of 83·7°. By applying the law of mass action and the law of the depression of the freezing-point by dissolved substances, the degree of dissociation of the partially racemic compound has been calculated to be about 50 per cent. It was also pointed out that other freezing-point curves indicate the existence of true racemates in the liquid state.

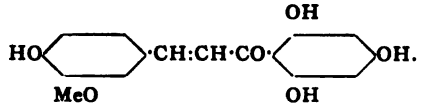
Discussion.

The President asked whether it had been proved that racemic compounds possessed double the molecular weight of the *d*- or *l*-compounds, and whether they might therefore be regarded as composed of one molecule of each variety.

Dr. Findlay, replying to Dr. Lowry, stated that calculations had not been made with regard to the stability of hydrated salts, but that the method of calculation referred to would be applicable also in such cases. In reply to the President, Dr. Findlay stated that the arguments adduced for the existence of a racemic compound held only for the fused state, not for solutions, although it is highly probable that undissociated racemic compounds exist to some extent even in solution.

*92. "*The Constitution of Homo-eriodictyol. A Crystalline Substance from Eriodictyon Leaves.*" By Frederick Belding Power and Frank Tutin.

The substance designated *homo-eriodictyol*, $C_{16}H_{14}O_6$ (m. p. 223°), previously isolated and described by the authors (*Pharm. Journ.*, 1906, lxxvii., 381, and *Abstr.*, 1906, xc., [ii.], 885), has now been further investigated. It is isomeric with hesperitin (*Ber.*, 1881, xiv., 970), and similar to the latter in many of its properties, but its sodium compound has the normal formula $C_{16}H_{13}O_6Na$ (compare Perkin, *Trans.*, 1898, lxxiii., 1037). Homo-eriodictyol contains one methoxyl group, and yields a *tetra-acetyl* derivative, $C_{16}H_{10}O_6(COMe)_4$ (m. p. 154°). On fusion with potash it gives protocatechuic acid. When homo-eriodictyol is hydrolysed with a concentrated aqueous solution of potassium hydroxide it yields phloroglucinol and ferulic acid (4-hydroxy-3-methoxycinnamic acid). From these results it is concluded that homo-eriodictyol must possess the following constitution:—



The "eriodyctionon" recently described by Mossler (*Annalen*, 1907, cccli., 233), is evidently identical with homo-eriodictyol.

Eriodictyol, $C_{15}H_{12}O_6$ (m. p. 267°), a crystalline substance which was also isolated by the authors from eriodictyon leaves (*loc. cit.*), contains no methoxyl group. When heated with acetic anhydride it yielded two compounds, melting at 137° and 195—196° respectively. It is considered probable that homo-eriodictyol is a monomethyl ether of eriodictyol.

93. "*The Relation between Valency and Heats of Combustion.*" (Preliminary Note). By Gervaise Le Bas.

It is now known that a valency is a volume property of the atoms (Barlow and Pope, *Trans.*, 1906, lxxxix., 1675; Le Bas, *Trans.*, 1907, xci., 312), and the author has found that valency may also be regarded as an energy property; this conclusion can be illustrated with the aid of the heats of combustion of the hydrocarbons.

The heat of combustion of a substance may be regarded

as made up of (*a*) an absorption of heat due to the dissociation or decomposition, and (*b*) an evolution of heat due to the combination of the isolated atoms with oxygen. A study of molecular heats of combustion, however, reveals the following law, which appears to be generally valid :— *The heat of combustion of an organic compound is equal to the sum of the heats of combustion of its possible dissociation products.*

The conclusion is therefore drawn that the factor *a* is negligibly small as compared with *b*. In illustration of this may be cited the facts that the heats of combustion of a normal paraffin and its carboxyl derivatives are identical provided that the physical state be taken into account, and that the heats of combustion of associated substances or of polymerides are the same as those of an equivalent number of simple molecules. It may be shown that the thermal constants of the alcohols, ethers, organic halogen compounds, carboxylic acids, esters, nitriles, amines, mercaptans, and other classes of compounds also follow this law.

The heats of combustion of organic compounds in most cases are found to be the same as those of saturated and unsaturated hydrocarbons and hydrogen, or of mixtures of these. Similarly, the factor *a* is negligibly small as compared with *b* in the case of the saturated and unsaturated hydrocarbons, and therefore their heats of combustion are sensibly those of their isolated atoms, *plus* an excess for the latter, owing to unsaturation. The additive relations obtained lead to a second law which applies to all the hydrocarbons.

The molecular heats of combustion of the hydrocarbons are proportional to their valency numbers W. For example, the heat of combustion of a normal paraffin, C_nH_{2n+2}, in the gaseous state is given by the expression M.H.C. $= (6n+2)c = W.c.$, c being a constant, representing the heat equivalent of one hydrogen atom expressed in large calories.

This law is illustrated by the following table, in which Thomsen's values are used :—

	W.	*c*.	W.*c*.	Calc. M.H.C.
Methane, CH_4 ..	8	26·49	211·7	211·9
Ethane, C_2H_6 ..	14	26·45	370·4	370·4
Propane, C_3H_8 ..	20	26·46	529·2	529·2
Butane, C_4H_{10} ..	26	26·43	687·9	687·2
Pentane, C_5H_{10} ..	32	26·46	846·7	847·0
Mean..		26·46		

The heat value of the difference for the homologous increment CH_2 is calculated to be equal to $6c = 6 \times 26{\cdot}46 = 158{\cdot}76$, which is similar to that observed.

The conclusion is also drawn that the molecular heats of combustion of compounds do not lend themselves to the determination of constitution. From certain peculiarities which are connected with olefine and acetylene linkings, it is, however, possible to recognise the presence of the latter in a compound with certainty.

94. "*The Velocity of Hydrolysis of Aliphatic Amides by Alkali.*" By James Codrington Crocker and Frank Harold Lowe.

The rate of reaction of the aliphatic amides with sodium hydroxide has been investigated at from 40·06° to 95·9°.

The reactions are shown to follow the bimolecular relation—

$$K = \frac{1}{at}\left[\frac{1}{c} - \frac{1}{c^0}\right],$$

where a is the degree of dissociation of the alkali. The graphs between the reciprocal of concentration and time are very approximately straight lines with a slight curvature indicating a small retarding effect of the neutral salt. If the amides are arranged in decreasing order of reactivity, this order is :—Formamide, acetamide, propionamide, capronamide, butyramide, *iso*butyramide, valeramide ; the temperature variation of reactivity over the above range is best expressed by the formula—

$$\log K = \log K^0 + B\left(\frac{1}{T^0} - \frac{1}{T}\right) + C\left(\frac{1}{T^0} - \frac{1}{T}\right)^2.$$

The mean differential coefficient of the graph between $\log K$ and $\frac{1}{T}$ for the above range is less than for the analogous case of hydrolysis by acid. The view is taken that hydrolysis by alkali of the amides proceeds by the direct action of the hydroxyl ion on the amide molecule. A modification of the Arrhenius hypothesis was suggested to explain the exponential variation of reactivity with temperature, a parallel being drawn between tautomeric change, where difference of property is produced by the "wandering" of an atom, and "electromeric" change, where difference of property is caused by the movement of an electron.

95. "*The Addition of Iodine to Acetylenic Acids.*" By Thomas Campbell James and John Joseph Sudborough.

Good yields of the di-iodides of tetrolic and phenylpropiolic acids are formed when a concentrated aqueous solution of cupric sulphate (1 mol.) is gradually run into a well-stirred aqueous solution of the potassium salt of the acid (1 mol.) mixed with an excess of potassium iodide. The di-iodides may be isolated by warming the solution, removing the cuprous iodide, and acidifying with a mineral acid.

The same di-iodides may be prepared by mixing aqueous solutions of the potassium salts with an excess of a potassium solution of iodine in iodide and allowing to stand for several days.

Definite di-iodides could not be isolated from *o*- and *p*-nitrophenylpropiolic acids, or from acetylenedicarboxylic acid, although in the two former cases an addition of iodine occurs.

Olefinic acids, even when they contain conjugated bonds, do not combine with iodine to any appreciable extent.

The velocity constants for the reactions between a solution of iodine in potassium iodide and the potassium salts of tetrolic, phenylpropiolic, *o*- and *p*-nitrophenylpropiolic acids have been determined. The reaction in each case is bimolecular when aqueous solutions are employed.

The reaction between iodine and phenylpropiolic acid has been studied in absolute alcohol and in aqueous alcoholic solutions, both with and without the addition of potassium iodide.

96. "*The Chemical Changes Induced in Gases submitted to the Action of Ultra-violet Light.*" By David Leonard Chapman, Samuel Chadwick, and John Edwin Ramsbottom.

An apparatus specially designed for the examination of the chemical changes brought about in gases by the influence of the light emitted from a mercury lamp was described. With the aid of the apparatus the conversion of oxygen into ozone, the interaction of carbon monoxide and oxygen, and the decomposition of carbon dioxide have been investigated particularly with a view to ascertaining the effect, in each case, of the presence of varying amounts of water-vapour.

Dry carbon dioxide is decomposed by ultra-violet light, the percentage decomposition being increased by a reduction of pressure, but, under the same conditions, the moist gas at all pressures remains practically unchanged. The rate of contraction of a mixture of carbon monoxide and oxygen is practically independent of the degree of desiccation of the gases, and this was found to be due to the fact that, although the presence of moisture causes the rate of formation of carbon dioxide to rise, it results in an equivalent reduction in the yield of ozone.

97. "*Studies of the Perhalogen Salts.*" (Part I.). By Charles Kenneth Tinkler.

The well known formation of periodides by the addition

of iodine to a solution of an iodide has been investigated by means of the ultra-violet absorption spectra of the solutions. Whilst neither a N/100 aqueous solution of iodine nor dilute solutions of iodides show any characteristic absorption in the ultra-violet, the aqueous solutions of iodine, after the addition of various iodides, all give the same spectra, which show a large amount of general absorption and two absorption bands.

Solutions of iodine to which various soluble bromides or chlorides have been added also give evidence, from their spectra, of the presence of addition compounds of the halogen salt and iodine.

It can be shown from the spectra of the solutions, that with equimolecular quantities of potassium iodide, bromide, or chloride, combination take place most readily with the iodide, and least with tbe chloride. On the addition of hydriodic, hydrobromic, or hydrochloric acids to the aqueous solution of iodine, the spectra of the solutions are the same as those containing the corresponding metallic salts; hydriodic acid, however, appears to combine with iodine when the acids are passed into a chloroform solution of this substance.

98. "*The Interaction of Cyanodihydrocarvone, Amyl Nitrite, and Sodium Ethoxide.*" By Arthur Lapworth and Elkan Wechsler.

Cyanodihydrocarvone, when subjected to the action of amyl nitrite and sodium ethoxide, is converted into a compound, isomeric with the expected *iso*nitroso-derivative, but which investigation has shown to be a *lactam*, $C_{10}H_{14}ON\langle^{NH}_{C}$; this is feebly acidic, and may be converted into a neutral *methyl* derivative, $C_{10}H_{14}ON\langle^{NMe}_{CO}$.

On treatment with dilute alkali these yield the corresponding *amino-acids*, from which they may again be obtained by means of dehydrating agents.

The lactams are converted by cold acids into *lactonic bases*,—

$C_{10}H_{15}ON\langle^{NH_2}_{CO}$ and $C_{10}H_{15}ON\langle^{NHMe}_{CO}$

which, on hydrolysis with hot dilute acids, yield ammonia and methyl amine respectively, together with a *lactonic acid*,—

$C_{10}H_{17}O_2N\langle^{OH}_{CO}$,

which, although it may be titrated in the cold as a monobasic acid, is probably not carboxylic in character; with warm alkalis the lactone ring is severed and the compound behaves as a dibasic acid.

All these compounds, by prolonged treatment with hot mineral acid, are converted into a pseudo*cumene carboxylic acid*, ($CO_2H : Me_3$ = probably 1 : 2 : 3 : 5). This is dimorphous, the forms melting at 84° and 105—106° respectively.

99. "*Contributions on the Chemistry of Oxygen Compounds. II. The Compounds of Cineol, Diphenyloxide, Nitroso-derivatives, and the Carbamides with Acids and Salts.*" By Robert Howson Pickard and Joseph Kenyon.

The authors have investigated the capacity of various compounds containing oxygen to form additive compounds analogous to those of the phosphine oxides (Part I., *Proc.*, 1906, xxii., 42) with the view of throwing some light on the influence (if any) of the phosphorus atom. No regularity can be observed in the molecular proportion of substances containing oxygen in their additive compounds.

It is suggested that the formation of additive compounds by sulphoxides and nitroso-compounds and the non-formation of the same, in general, by sulphones, nitro- and azoxy-compounds is probably due to the position of the oxygen atoms of the latter in a ring, so that any subsidiary or residual valency is internally satisfied. As the aryl substituted carbamides form salts, and as, in general, the carbamides behave in regard to the formation of additive compounds in a similar manner to the phosphine oxides, cineol, &c., it is probable that the additive compounds formed by the carbamides are due to the subsidiary valency of the oxygen atom, which in these compounds, as in the phosphine oxides, is influenced by the proximity of the nitrogen or phosphorus atom respectively. The additive compounds of cineol with magnesium alkyl halides are decomposed when heated, and the product when treated with dilute acid yields Δ^1-*p*-terpineol (8).

Research Fund.

A meeting of the Research Fund Committee will be held in June. Applications for grants, to be made on forms which can be obtained from the Assistant Secretary, must be received on or before Saturday, June 8th, 1907. Those Fellows who received grants in June, 1906, or whose grants, allotted in June of previous years, have not been closed, are reminded that reports must be in the hands of the Hon. Secretaries not later than Saturday, June 1st.

Erratum.—P. 236, col. 2. line 16 from bottom, *for* "Toluoyl" *read* "Phenylacetyl."

PHYSICAL SOCIETY.

Ordinary Meeting, May 10th, 1907.

Prof. J. Perry, F.R.S., President, in the Chair.

A paper entitled "*Stereoscopy with Long Base-line, Illustrated on the Screen*" was read by Dr. T. C. Porter.

The present paper containing suggestions and extensions of stereoscopic work is largely the same as that read to the Royal Photographic Society on January 29th of the present year. The use of a long base-line for tele-stereoscopy had occurred to M. Selb, of Brussels, and in 1903 he obtained stereoscopic mountain photographs. The applications of the method for military, geographical, and meteorological purposes, although obvious, do not seem to have been used before, and the author discusses the possibilities of these applications. The paper opens with a brief sketch of the principles of stereoscopy, and describes an attempt to measure the limit of stereoscopic vision for the unassisted eye. The power we possess of judging of the difference in distance of two objects in our field of view depends, first, upon various properties of those objects which vary with the said distance, variations to appreciate which we require strictly but one eye, though it may well be that we appreciate them better with two. These properties are the apparent size, the clearness or haziness of an object, the arrangement of light and shade, and the shadows cast, and fourth, the apparent motion of the object. The next means of telling the different distances of objects depends —not on the properties of the objects themselves—but on one of the eye itself. It is the effort, made quite instinctively, by which we bring the images of objects to a sharp focus on the retina, *i.e.*, by the effort made in so-called accommodation. The power of accommodation is, however, comparatively limited in its scope, the author's experiments putting the limit for ordinary sight at about six feet from the eye. On these various methods and on the mental deductions following from them and founded on previous experience, depend the whole of the powers of appreciating form and distance, so far as each eye is considered separately. The impressions received by the two eyes when regarding any near object are not the same,

because each eye sees from its own position, which differs from that of the other eye by about 2·5 inches in most cases. When an observer wishes to examine a near object he must turn each eye inwards by a certain angle θ, and this he does by making a definite effort. It is this effort of convergence which gives the sensation of spectroscopic relief. When the object is so far removed from the eye that the angle θ, or the convergence for one eye, becomes too small to be appreciated, and therefore also the effort necessary for the convergence through this small angle becomes inappreciable, the stereoscopic sensation fails. In other words, stereoscopic sensation will be limited to objects nearer the observer than this distance, which is thus the spectroscopic limit. The author's experiments place this distance for average persons at about 43 feet. The range of stereoscopic effect varies directly as the length of the base-line. If the distance between the eyes could be increased ten times, the stereoscopic effect would be perceptible to a distance of 430 feet. Such an increase of base-line can be made to all intents and purposes by means of reflectors, and this was first done by Helmholtz. The base-line can also be increased by taking two photographs of distant objects from two different points and viewing them in a stereoscope. However long the base-line, so long as its two ends are about the same distance from the objects, and so long as the objects themselves are clear enough and large enough to yield a picture, we have the means of determining the forms and relative distances of the objects however far off they may be. The author showed upon the screen numerous stereoscopic pictures of distant objects, mountains, clouds, &c., and discussed the value of the pictures for military, geographical, and meteorological investigations.

Mr. J. Tennant expressed his interest in the paper, and said he had shown pictures of clouds, taken by the same method as that employed by the author, in a paper published in 1897. He was not certain that the feeling of convergence was the only thing which determined stereoscopic vision. The estimate of 43 feet as the limit of stereoscopic vision seemed to him too small, as he had observed stereoscopic effects at distances up to 125 yards. In 1896 he devised a stereoscopic camera, and used it to measure the heights and depths of clouds. In some of his cloud experiments he had used a base-line three-quarters of a mile long. The method was applicable to many subjects, and was a most valuable one.

Mr. Crawley said the author's determination of the angle θ was very much larger than that given by Helmholtz. The methods described by the author had been used by Pulfrich in surveying and astronomical work.

NOTICES OF BOOKS.

The Value of Pure Water. By George C. Whipple. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1907.

This book appeared originally as a collection of scientific papers, entitled "Biological Studies by the Pupils of William Thompson Sedgwick," which attracted a considerable amount of attention. The author was therefore induced to revise and publish them in book form, adding to them some extracts from lectures on aspects of the water supply question delivered at the Brooklyn Polytechnic Institute and elsewhere. The main idea is the comparison of different waters upon a financial basis, and it is very ingeniously worked out. Provisional formulæ are suggested which express approximately the depreciation due to sanitary qualities, physical characteristics, hardness, and temperature. The results obtained are then tabulated and represented graphically, and they give some idea of how to compute the value of pure water in terms of money, and should assist public authorities in deciding whether they would be justified in incurring the cost of filtration and purification. In some cases the formulæ necessarily rest more upon estimates than upon statistics, and will undoubtedly be modified in time, but the author's suggestions are of real practical value, and are worth the attention of those who are interested in the question of providing as pure water as possible for the use of the public.

Eleetro-chemistry. By Dr. Heinrich Danneel. Translated by Edmund S. Merriam, Ph.D. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1907.

Although the treatment of theoretical electro-chemistry in this book is slight, it is sufficient to give those who are quite unacquainted with the subject a useful idea of its elements, and thus it may serve as an introduction, accurate as far as it goes, to the study of larger works. In later volumes Dr. Danneel hopes to discuss experimental electro-chemistry and its applications. The practical importance of electro-chemistry in the manufacture of various substances, otherwise difficult or expensive to prepare, and in the storing and transporting of energy, is growing so rapidly that all students of science should have at any rate an elementary knowledge of it, and those who are not going to specialise in the subject will find the book sufficiently full for their requirements. In this volume chemical statics and dynamics are discussed very briefly, and a clear exposition is given of the theory of electrolytic dissociation. The translation has been carefully performed, and the book will be found to give a clear account of the outlines of electro-chemistry.

Uber die Elektrolytische Gewinnung von Brom und Iod. ("The Electrolytic Preparation of Bromine and Iodine"). By Dr.-Ing. Max Schlötter. Halle-a.S.: Wilhelm Knapp. 1907.

The greater part of this book is devoted to the preparation of bromine, the methods of extracting iodine electrolytically being of much less interest and importance. Like the other volumes of the series of Monographs on Applied Electro-Chemistry, the book is characterised by the great thoroughness with which the subject is treated, and the fulness of the references to original papers which make them of considerable value as works of reference. The chemical methods of preparing bromine are treated shortly, while all the successful processes in which electrolysis is employed are described in detail. Information relating to yield is given, and the purification of bromine and its analysis are the subjects of two chapters. The preparation of iodine naturally requires very much less space, the electrolytic method having as yet been but little investigated, though there are indications that it will shortly be the subject of additional exhaustive research.

Essais de Jean Rey ("Essays of Jean Rey"). Edited by Maurice Petit. Paris: A. Hermann. 1907.

The name of Jean Rey is but little known to students of the history of chemistry, and the exact part he played in the furtherance of chemical knowledge perhaps even less; his fundamental work has been most unjustly overlooked, and this reprint of his lectures will therefore be all the more acceptable. If the reader will take the trouble to conquer the old French in which they are written, and which will present but little difficulty, he will find that the book is really the earliest treatise on physics, and, moreover, one which contained the account of a discovery of great importance. Jean Rey, with unique acumen to aid him in his speculations, and steady patience in collecting material, was the first of the philosophers of the Seventeenth Century to suggest and prove that the air has weight, and

that the increase of weight of the metals tin and lead upon calcination comes from the air, and is not due to vapours of carbon, soot, "volatile mercurial salt," or, in fact, any of the causes to which the ingenuity of his predecessors had ascribed it. The essays show Rey to have been an acute reasoner and close observer, and deserve to rank among the classic masterpieces of chemistry. In this edition the editor contributes explanatory notes, while the comments of Gobet, who brought out an edition in 1777, are also included. The text follows closely that of the original, which was published in 1630.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 17, April 29, 1907.

Direct Hydrogenation of Allyl Compounds.—Paul Sabatier.—The ordinary methods of hydrogenating allyl alcohol in the wet way do not readily transform it into propyl alcohol. Thus, sodium amalgam and water, and zinc in presence of hydrochloric acid, have no effect upon it, while Linnemann found that zinc and dilute sulphuric acid, after standing twenty-five hours at the ordinary temperature, convert one-third of the alcohol into propyl alcohol. The hydrogenation is, however, effected quite easily by blowing the vapour of allyl alcohol by means of hydrogen upon reduced nickel at a temperature between 130° and 170°. Almost pure propyl alcohol is thus obtained. Reduced copper at temperatures above 180° can also be used, but the reaction proceeds far more slowly, and the product contains traces of allyl aldehyde. By the same method, allyl oxide can be completely transformed into propyl oxide.

Temperature of Formation of Carbides of Strontium and Barium.—Morel Kahn.—The author placed a mixture of the oxide of one of these metals and carbon in a graphite crucible covered by a lid of the same material and fitting into a closed crucible of quicklime. The space between the two walls was filled with sugar carbon. It was found that in these circumstances the graphite crucible is hardly attacked at all. Platinum was fused in this crucible in ten minutes at the most in the electric furnace. In the case of strontium 10·3 grms. of the oxide were mixed with 3·6 grms. of carbon, *i.e.*, the theoretical quantity, and 5 or 6 grms. of this mixture were heated for twenty minutes to a temperature at least as high as the melting-point of platinum (1775°). All the oxide was then converted into carbide. With barium oxide the same result was obtained, and thus the oxides of strontium and barium are reduced by carbon at temperatures in the neighbourhood of the melting-point of platinum.

Preparation and Properties of a New Variety of Chromium.—Binet du Jassonneix.—When chromium boride, containing 10 to 15 per cent of boron, is heated in the electric furnace in crucibles of magnesium oxide in presence of a great excess of copper, and kept for three or four minutes at the boiling-point of this metal, dissociation occurs; the boron is volatilised and the chromium dissolves in the copper and separates out on cooling in a very finely divided state. To prepare more of this modification of chromium, the carbide (containing 5 to 7 per cent of carbon) and the metal (containing 0·7 per cent of silicon and 1·2 per cent of aluminium) were treated similarly. The results obtained were identical. The chromium thus prepared, which may be separated from the copper by dissolving the latter in nitric acid, forms a mass of filaments and little crystals. Its density at 17° is 7. It possesses the chemical properties of pure chromium, but is distinguished from it by the readiness with which it reacts. It does not oxidise in the air, but burns in contact with a flame. Thus, at a high temperature copper dissolves about 1·6 per cent of chromium, and the latter separates out on cooling in a very finely-divided state.

Limit of the Action of Silicon upon Copper.—Em. Vigouroux.—When copper, lead, and silicon in excess are placed in a porcelain boat and heated in a current of hydrogen, it is found that the proportion of combined silicon to copper is roughly 10 : 100, which corresponds to the compound Cu_4Si. When either bismuth or aluminium is substituted for lead, practically the same results are obtained. The silicide is not evenly distributed in each of the three metals. With lead and bismuth the greater part of it floats upon the surface, while with antimony it is distributed uniformly throughout the metal. In all cases the compound Cu_4Si is formed.

Higher Oxides of Rubidium.—E. Rengade.—The author has studied the direct oxidation of rubidium, using his apparatus in which a given weight of metal in an aluminium boat is subjected to the action of known volumes of pure oxygen. The gas is introduced gradually into the apparatus, so that too great an evolution of heat is avoided. When a sufficient volume has been absorbed the aluminium boat is heated till its contents fuse and a homogeneous product is obtained. When the quantity of oxygen corresponds to that required for the formation of the oxide, Rb_2O_2, a yellowish white mass is produced, which fuses at about 600° to a brown liquid, and solidifies on cooling to a mass of needles. If the quantity of oxygen is increased the mass remains dark brown after solidification, and with a rather greater proportion of oxygen becomes quite black, and then does not alter in colour till the maximum of oxidation, corresponding to the peroxide, Rb_2O_4, is reached. The peroxide is yellow when it has been kept for some time in the fused state and cooled in an atmosphere of oxygen at ordinary pressure. When fused *in vacuo* it remains brownish black after cooling, because it dissociates very easily, giving up oxygen *in vacuo* at 500°. If it is kept at 550°, and the oxygen is removed as it is liberated, the black oxide is obtained. Its formula is Rb_2O_3. This trioxide may be prepared more easily by allowing the theoretical amount of oxygen to act upon rubidium and heating to the melting-point. The density of the black mass is 3·53, which differs considerably from the mean of the densities of the dioxide and peroxide, and its melting-point is below 500°, while the other oxides fuse at temperatures above 600°.

Isomeric Di-oximido-succinic Acids.—A. Wahl.—When the nitrate or chlorhydrate of hydroxylamine is allowed to act upon sodium di-oxytartrate, a mixture of nitroso-cyanacetic acid and ββ-di-oximido-succinic acid is obtained. If the ethereal solution obtained by repeatedly extracting the product of the reaction with ether is evaporated, a thick liquid is produced, from which a yellowish crystalline mass separates. By a long series of fractional crystallisations of this with a mixture of anhydrous ether and benzene the following products can be obtained:— (1) Oxalic acid; (2) isonitrosocyanacetic acid; (3) crystals of the composition $C_4H_4N_2O_6 + \frac{1}{2}C_6H_6$. These lose their benzene of crystallisation at 190° and then have the exact composition of di-oximido-succinic acid, $C_4H_4N_2O_6$. This acid is soluble in water, alcohol, and ether; it melts at 168° to 170°, undergoing decomposition. The aqueous solution of the crystals gives with copper acetate a voluminous green precipitate, transformed on heating into blue-green crystals. These properties distinguish the acid from Söderbaum's two isomers, which both melt at 145° and 150°, and of which one, the ββ-acid, gives a green precipitate turning brown with acetate of copper. If a current of dry hydrochloric acid gas is passed into a solution of ethyl di-oximido-succinate (melting-point 196°) in anhydrous ether, and the solution is evaporated

n vacuo in presence of caustic potash, a white crystalline residue is left. This is the isomeric ethyl di-oximido-succinate, which differs from the first in its melting-point (143°), solubility in water, and reaction with silver nitrate.

Dibromides of Phenol Allyl Ethers. Formation of Cyclopropanols.—Tiffeneau and Daufresne.—When the dibromides of phenol allyl ethers are heated with alcoholic potassium acetate aceto-bromhydrines are formed.

$$Ar—CH_2—CHBr—CH_2Br \rightarrow Ar—CH_2—CH(O—CO—CH_2)—CH_2Br.$$

These latter substances are converted into cyclopropanols when heated with alcoholic potash:—

$$Ar—CH_2—CH(O—CO\text{-}CH_2)—CH_2Br \rightarrow Ar\text{-}CH\!<\!\begin{matrix}CHOH\\CH_2\end{matrix}$$

The cyclopropanols are distinguished by their high densities, while the isomeric oxides of ethylene, $Ar—CH\!<\!\begin{matrix}CH—CH_2\\O\end{matrix}$, have low densities. Moreover, the former are transformed into arylacetones, $Ar—CH_2—CO—CH_2$, and the latter into hydrocinnamic aldehydes, $Ar—CH_2—CH_2—CHO$.

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Berichte der Deutschen Chemischen Gesellschaft.
Vol. xl., No. 7, 1907.

Conversion of Magnesium Organic Compounds into Amino Complexes, and their Thermo-chemical Investigation.—W. Tschelinzeff.—The author's experiments show that the magnesium organic compounds are capable of forming complexes with tertiary amines, which are completely analogous to the mono-etherates, and more or less heat is simultaneously evolved. No compounds analogous to the di-etherates are formed under ordinary conditions. As regards the influence of the radical upon the thermic effect of the union with the tertiary amines, and hence also upon the nature of the nitrogen atom, it is found that as the mass of the radical increases in the fatty series the nature of the nitrogen atom alters in such a way that the thermic effect of the action upon the amine slowly falls; when aromatic amines are used the strongly negative influence of the aromatic radical leads to a fall in the thermic effect. It is found that more heat is evolved when ammonium compounds are formed than on the formation of the oxonium salt.

Determination of Aluminium in Silicates.—F. Willy Hinrichsen.—When aluminium oxide is precipitated with ammonia, hydrofluoric and sulphuric acids, the values obtained are always lower than when potassium-sodium carbonate is used, the loss in some cases amounting to about 30 per cent of the total. To explain this it was conjectured that possibly some of the aluminium was converted by the hydrofluoric acid into fluoride, and then volatilised, although as the temperature was low no very great loss could be caused thus. It was actually found that when freshly precipitated aluminium hydroxide is treated with hydrofluoric acid, evaporated, and ignited in a covered crucible, somewhat lower values are obtained than those which correspond to the aluminium oxide used. The difference is, however, only small, and there must therefore be some other source of error in precipitating aluminium oxide with ammonia, and adding hydrofluoric and sulphuric acids. It was then found that the last traces of hydrofluoric acid are retained by sulphuric acid in presence of alumina. Possibly some ammonium fluoride is formed, which then reacts on the hydroxide as follows:— $Al(OH)_3 + 3NH_4F = AlF_3 + 3NH_4OH$. When a solution of aluminium sulphate is acidified with hydrofluoric acid, ammonia is added, and the whole cooled, a crystalline precipitate of the double salt, $(NH_4)_3AlF_6$, separates out. Thus the difference between the found and calculated values is due to the fact that the salt was not completely freed from a small amount of ammonium fluoride, and the amount of fluorine retained depends upon whether the vessel is heated evenly on all sides or only from beneath. In this method of determining aluminium the sulphuric acid must be completely evaporated, and the residue ignited at a low temperature in order to expel all the fluorine.

Cerium Sesquioxide.—Alfred Burger.—The reduction of cerium dioxide by means of metallic calcium does not yield the metal, but a substance which on analysis is found to be the sesquioxide. The author's experiments with calcium led to the formation of a light yellowish green powder. This was treated with ammonium chloride solution, and cooled to −10°. After it had stood for an hour the oxide was rapidly separated off, washed with ice-water, alcohol, and ether, and dried *in vacuo* over sulphuric acid. When heated it yields the dioxide at about 200°. Also when kept in closed vessels it takes up oxygen comparatively easily.

MISCELLANEOUS.

Royal Institution.—On Tuesday next, May 28, at 3 o'clock, Prof. G. H. F. Nuttall delivers the first of two lectures at the Royal Institution on "Malaria, Sleeping Sickness, Tick Fever, and Allied Diseases," and on Saturday, June 1, Sir William White begins a course of two lectures on "The Contest between Guns and Armour." The Friday Evening Discourse on June 7 will be delivered by Prof. Sir James Dewar, on "Studies in High Vacua and Helium at Low Temperatures."

MEETINGS FOR THE WEEK.

TUESDAY, 28th.—Royal Institution 3. "Malaria, Sleeping Sickness, Tick Fever, and Allied Diseases," by Prof. G. H. F. Nuttall, F.R.S., &c.
— Society of Arts, 8. "Sheffield Plate and Electro-plate," by Sherard Cowper-Coles.
— Faraday Society, 7.50. Annual General Meeting. "Contributions to the Chemistry of Gold," by F. H. Campbell. "Reduction of Oxides, Sulphides, &c., by means of Metallic Calcium," by F. M. Perkin. Exhibition of Thermostatic Apparatus, by T. M. Lowry.
THURSDAY, 30th.—Royal Institution, 3. "Chemical Progress—Work of Berthelot, Mendeleeff, and Moissan," by Prof. Sir James Dewar, F.R.S., &c.
— Society of Arts, 4.30. "Irrigation Colonies in India," by Laurence Robertson, I.C.S.
FRIDAY, 31st.—Royal Institution, 9. "Recent Journey Across Africa," by A. Henry Savage Landor.
SATURDAY, June 1st. Royal Institution, 3. "The Contest between Guns and Armour," by Sir William H. White, K.C.B., F.R.S., &c.

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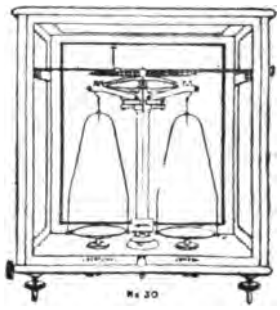

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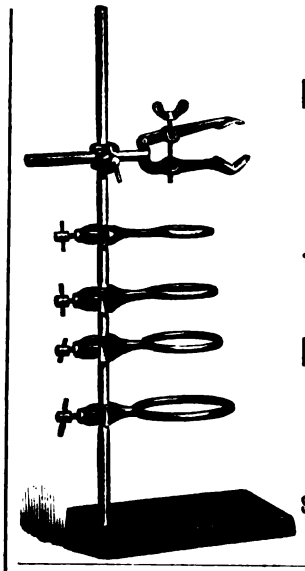

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THE VOLUMETRIC ESTIMATION OF FREE ACID IN PRESENCE OF COPPER AND OTHER METALLIC SALTS.

By W. EDGAR SIMS, M.Sc. (Vict.).

THE various methods which have been proposed for the estimation of free acid in solutions of metallic sulphates, and especially in copper solutions, such as galvano-plastic bath liquors, are either tedious and complicated or wanting in accuracy, owing to the difficulty of obtaining an indicator giving a sharp and definite end-reaction on neutralisation of the free acid.

Sutton in his book on Volumetric Analysis recommends the use of a standard ammoniacal copper solution, which, though giving reliable results, must be frequently re-standardised on account of its liability to alter in strength. For the estimation of free sulphuric acid in copper sulphate solutions F. Hoffmann (*Chem. Zeitung*, xvii., 1318) devised the following method :—A small quantity of copper solution, containing about 2 to 3 grms. $CuSO_4.5H_2O$, is precipitated by a slight excess of potassium ferrocyanide, made up to a certain volume, and allowed to settle. The clear solution is filtered from the precipitate of ferrocyanide of copper, and titrated with standard caustic alkali. The author also states that the effect of small quantities of proto-salts, on the results, is very slight, and may for technical purposes be overlooked.

Woginz and Kittel (*Chem. Zeitung*, xxx., 1300) recommend direct titration of the free acid in galvano-plastic baths, with standard caustic alkali, using Congo-red paper as an indicator. R. T. Thomson in his excellent paper on Indicators pointed out that the sulphates of copper, zinc, and iron are neutral to methyl-orange, and R. M. Caven (*Journ. Soc. Chem. Industry*, 1900, xviii.) in his work on "The Reaction of Magnesium, Zinc, and Iron with Solutions of Copper Sulphate," adopted this indicator for the estimation of free acid in solutions of the sulphates of the above metals. The method adopted was as follows :—A blank solution was prepared containing the same amount of the sulphates of copper, zinc, or iron as the solution to be tested. Equal quantities of the solution of methyl-orange were added to the two liquids, and the purple solution containing the free acid titrated with N/10 caustic alkali, until its colour matched the pure green of the blank solution. All of these methods are more or less wanting in sharpness of the end reaction, and the use of caustic alkali is objectionable on account of its tendency to precipitate the metallic hydrates during momentary local alkalinity, which also mask the end reaction besides reducing the accuracy of the test. After many experiments a method was devised free from these objections, in which the solution remains absolutely clear during the titration, even when the alkali is in slight excess; the utility of the test is greatly increased thereby, as it is capable of being carried out by an intelligent workman.

The method is dependent upon the following conditions :—1. The bicarbonates of these metals are slightly but sufficiently soluble for the purpose of keeping the solution clear, and are neutral to methyl-orange, whereas bicarbonate of soda is strongly alkaline to the same indicator. 2. The red colour of an acid solution of methyl-orange and the blue colour of a sulphate of copper solution are complementary, and when mixed in the proper proportions give an almost colourless solution. For example, if to 100 cc. of a 3 per cent solution of pure copper sulphate four drops of a methyl-orange solution be added, a pure yellowish green colour is produced. If to this green solution a N/2 solution of sulphuric acid be carefully added, it will be noticed that after the addition of two drops or 0·1 cc. the solution becomes practically colourless. At this stage the further addition of one drop of N/2 acid produces a distinct pink coloration, whilst the addition of one drop of N/2 bicarbonate of soda produces a distinct green coloration, the original green of the neutral solution only being obtained after the addition of two drops or 0·1 cc. of the N/2 bicarbonate. The further addition of bicarbonate produces no marked change in colour, and no precipitate until a considerable excess has been added.

The colourless stage of the solution and the remarkably sharp change to pink or green according to whether an excess of acid or alkali is added, gives an excellent indicator in the titration of the free acid in solutions of sulphate of copper, even when containing large proportions of the sulphates of nickel, iron, zinc, &c.

The titration is carried out in the following manner :—Three grms. of the sulphate of copper crystals or such a quantity of the solution to be tested as would contain about that weight of sulphate of copper, is put into a 10 oz. conical flask, and diluted with 100 cc. of distilled water, then add four drops of methyl-orange solution. If the colour produced is pink, the solution is titrated with N/2 bicarbonate of soda until the colourless stage is reached; the amount of free acid in the material tested is equivalent to the number of cc. of N/2 carbonate used, plus 0·1 cc. If, however, the colour produced on the addition of the methyl-orange is green, then the acidity of the solution cannot be greater than the equivalent of 0·1 cc. N/2 bicarbonate, and in this case the solution is titrated to the colourless stage with N/2 acid; the amount of free acid in the solution is therefore equivalent to 0·1 cc. minus the number of cc. of N/2 acid used.

The determination of the free acid in solutions of sulphate of copper by this method is accurate to 0·04 per cent of free acid on the weight of sulphate employed, but involves a constant correction of 0·08 per cent or 0·00245 grm. H_2SO_4 above the actual amount shown by titration with N/2 bicarbonate to the colourless stage.

The end reaction is still sharp in 5 per cent solutions, and if preferred N/10 solutions of acid and bicarbonate may be employed, but for all practical purposes the above strengths will be found most suitable for works or laboratory use.

The method is also applicable to salts of nickel or iron, &c.; such, for example, as galvaniser's "pickle," in which case stronger solutions may be employed than with coloured salts, such as sulphate of copper or nickel.

A VOLUMETRIC METHOD OF ESTIMATING MERCURY.

By P. W. ROBERTSON.

DOUBLE mercuric sulphocyanides of the type $XHg(CNS)_4$, where X is a divalent metal, such as zinc, cadmium, or copper, were prepared by Clève some fifty years ago (*Journ. Prakt. Chem.*, xci., 227). Since that time other similar compounds have been obtained, and it has become generally recognised that the grouping $Hg(CNS)_4$ acts as a complex ion. Clève described the zinc salt, $ZnHg(CNS)_4$, as a slightly soluble crystalline substance. The composition of this compound was confirmed by the following three methods :—

(*a*) Direct determination of the mercury by distillation with lime of a sample dried at 100°. Hg = 39·9 per cent, calculated for $ZnHg(CNS)_4$ = 40·2 per cent.

(*b*) Synthesis of the salt from a known weight of mercury.

Mercuric oxide was dissolved in dilute nitric acid, and enough ammonium sulphocyanide was added to dissolve the precipitate of mercuric sulphocyanide first formed. To

this solution was then added excess of zinc sulphate, and the precipitate was collected on a Gooch crucible, and dried at 100°. Hg = 40·0 per cent, calculated 40·2 per cent.

(*c*) The amount of sulphocyanide required to precipitate a definite quantity of a solution of mercuric nitrate in dilute nitric acid was found by titrating the excess with standard silver nitrate. Numerous determinations at different dilutions and with varying excesses of zinc sulphate and sulphocyanide yielded results in accordance with the above formula.

A determination of the solubility of zinc mercuric sulphocyanide at 15° showed that 1000 grms. of water dissolved 2·4 grms. of the salt. In the presence of excess of zinc ions the solubility is considerably reduced, so that if an excess of a zinc salt is employed and the precipitate is washed with a solution of this salt, it is evident that the insolubility of this double compound can be employed to serve as a method of volumetric analysis of mercuric compounds by a titration of the excess of sulphocyanide used for the precipitation. This conclusion was fully justified by experiment, and the method of analysis finally adopted was as follows:—

To a solution containing about 0·04 grm. of mercury in the form of a mercuric salt (chlorides must be absent owing to the use of silver nitrate in the titration) are added 10 cc. of decinormal ammonium sulphocyanide, and then excess of zinc sulphate solution. The precipitate is filtered and washed several times with dilute zinc sulphate. The filtrate is treated with 10 cc. of decinormal silver nitrate, and the excess of silver is determined in the usual manner by titration with decinormal sulphocyanide, employing ferric sulphate as an indicator. Working in this manner 1 cc. of sulphocyanide is equivalent to 0·005 grm. of mercury in accordance with the formula $ZnHg(CNS)_4$.

With smaller quantities of mercury it is advisable to employ N/20 solutions, in which case 1 cc. is required to precipitate 0·0025 grm. of mercury.

The method appears capable of considerable accuracy, and an estimation can be performed in less than five minutes. Excess of nitric acid does not influence the result, and hence the method may be applied to mercurous salts by first boiling with nitric acid and then diluting. For every 0·05 grm. of mercury there must be at least 10 cc. N/10 sulphocyanide, and care must be taken to have excess of zinc sulphate for precipitation. Further, it is advisable not to work at too great dilutions. It is essential that chlorides should be absent.

Balliol and Trinity College Laboratory, Oxford.

A POSSIBLE EXPLANATION OF THE INCREASE IN VISCOSITY WHICH RESULTS WHEN THE ALCOHOLS ARE MIXED WITH WATER, AND OF THE NEGATIVE VISCOSITY COEFFICIENTS OF CERTAIN SALTS WHEN DISSOLVED IN WATER.

By HARRY C. JONES and W. R. VEAZEY.

IT is well known that when methyl or ethyl alcohol is mixed with water the viscosity of the mixture is much greater than that of either pure liquid. The following seems to us to be a possible explanation of this phenomenon:—

It was shown some time ago by Jones and Murray (*Am. Chem. Journ.*, 1903, xxx., 205) that when two associated liquids, such as formic acid and water, or acetic acid and water, and, probably, such as alcohol and water, are mixed, each diminishes the association of the other. The result would be that in such a mixture there would be present a *larger number of smaller molecules* than if the two liquids simply mixed without affecting each other's association.

This diminution in the association of the liquid molecules, increasing their number and diminishing their size, would increase the viscosity by increasing the total frictional surfaces of the molecules that would come in contact with one another—the smaller the molecules the larger the total surfaces of the molecules for a given mass of the liquid.

The above point can be illustrated by means of small shot and large shot. For a given mass, the smaller shot moving over one another would produce greater friction than the larger shot, due to the larger frictional surfaces that would come in contact. The same applies to the molecules of the mixed solvents.

The comparatively small association of the molecules of the mixed solvents explains another phenomenon which has manifested itself in a number of the investigations recently carried out in the Physical Chemical Laboratory, Johns Hopkins University (Jones and Lindsay, *Am. Chem. Journ.*, 1902, xxviii., 329; Jones and Carrol, *Ibid.*, 1904, xxxii.. 521; Jones and Bingham, *Ibid.*, 1905, xxxiv., 481; Jones and McMaster, *Ibid.*, 1906, xxxvi., 325). In those mixtures of solvents where the *viscosity is a maximum, the conductivity curve of many dissolved electrolytes shows a minimum*. As the conductivity curves, for the solutions of different concentrations of a given salt in different mixtures of two solvents, *approach the minimum, they approach one another*. This means that the molecular conductivities do not increase rapidly in these particular mixtures of the two solvents, with change in the dilution of the solution. This is exactly what would be expected if the molecules of the solvents in the mixture were only comparatively little associated. They would then have comparatively little dissociating power, and the conductivity in such a mixture of solvents would increase only slowly with increase in the dilution of the solution. The curves for molecular conductivity would therefore approach one another, as they approach the minimum.

It was observed in the course of our work that solutions of potassium sulphocyanate in water are *less viscous than pure water*. On looking up the literature that bears upon this problem, and especially the work of Wagner (*Zeit. Physik. Chem.*, 1890, v., 31), we find that a number of salts show this negative viscosity coefficient. They are potassium chloride, potassium nitrate, rubidium chloride, and cæsium chloride. Thallous nitrate also, apparently, shows the same phenomenon.

The explanation of this *negative viscosity coefficient* is comparatively simple, in the light of what has already been said in reference to viscosity.

The salts with the negative viscosity coefficient are, then, certain salts of potassium, rubidium, and cæsium. The case of thallous thallium will be considered a little later. If the *ions of the salt were very large*, relative to the molecules of the solvent, then the effect of the dissolved substance on the viscosity of the solvent would be to diminish it. This will be seen at once, if we think of a number of larger spheres mixed with a much larger number of smaller spheres. The frictional surfaces would be diminished, and, consequently, the friction, when these spheres move over one another.

The question is whether there is any reason to suppose that the ions of potassium, rubidium, and cæsium are large. If we turn to the curve of atomic volumes we find the answer (Lothar Meyer, "Die Moderne Theorien der Chemie"; Holleman, "Inorganic Chemistry"; Jones, "Elements of Physical Chemistry"). As is well known, potassium, rubidium, and cæsium occupy the maxima of the atomic volume curve, and these three elements have *much larger atomic volumes* than any other known elements.

The *qualitative* agreement of fact and theory are thus in accord, with the exception of the thallous salt. Since, however, we do not know at present the atomic volume of thallous thallium, this case will have to be left out of the discussion.

If we wish to test the above suggestion *quantitatively* we have the means of doing so. Potassium has a much larger atomic volume (about 47) than any other element except rubidium and cæsium. The atomic volume of rubidium is about 57, while the atomic volume of cæsium

is about 74. If we compare the viscosities of the same salt of these three elements, say the chlorides, we should expect to find, in terms of our hypothesis, that the viscosity coefficient would be less for rubidium chloride than for potassium chloride, and less for cæsium chloride than for rubidium chloride.

From the work of Wagner we can make the above comparison. The time of flow of pure water through the viscometer is taken as the unit of value for η. The values of η for normal solutions of potassium chloride, rubidium chloride, and cæsium chloride are:—

	η.
Potassium chloride	0·9872
Rubidium chloride	0·9846
Cæsium chloride	0·9775

It is worth noting that the difference between the values of η for cæsium chloride and rubidium chloride is much greater than the difference between rubidium chloride and potassium chloride. This is in keeping with the relative atomic volumes of the three elements. The difference between the atomic volume of rubidium and cæsium is much greater than the difference between the atomic volume of rubidium and potassium.

The question now arises whether, *e.g.*, all potassium salts show the negative viscosity coefficient. The answer is that they do not. The reason for this is obvious when we consider that the effect of a salt on the viscosity of a solvent is an additive function of both of the ions present in the solution. The anion, so far as we know, always tends to increase the viscosity of water, while certain cations, as those above considered, diminish the viscosity of water. The action of the salt, as a whole, upon the viscosity of water, is the algebraic sum of these effects, which may be either positive or negative.

Wagner (*Zeit. Phys. Chem.*, 1890, v., 36, 37) studied six salts of potassium in this connection, and found values of η less than unity only in the case of the chloride and nitrate. In the other four cases the action of the anion more than overcame the effect of the cation, and η was always greater than unity. *The chloride gave a negative value for η.* This would be expected, since *chlorine has itself a large atomic volume;* indeed, larger than that of any other elementary anion except bromine. This would, then, probably act in the same way as the potassium cation, giving a negative coefficient; or, if the coefficient due to chloride were positive, it would have a very small value.

For the same reason potassium nitrate shows a large negative viscosity coefficient.

If we extend the above conception to other cations with large atomic volumes, but with much smaller atomic volumes than the three alkalis, we shall find that it holds satisfactorily. Taking calcium, strontium, and barium, which, of all cations, have the next larger atomic volumes, and comparing their chlorides with respect to the values of η, we have, for normal solutions:—

	η.
Calcium chloride	1·1563
Strontium chloride	1·1411
Barium chloride..	1·1228

These values are all positive, as we should expect them to be, but their order is exactly *the reverse of the atomic volumes*, just as would be expected.

Chlorides with cations of still smaller atomic volumes have values of η much larger than the above. This will be seen from the following table, where all the values of η refer to normal solutions. In the same table are given the approximate atomic volumes of the cations of the several chlorides:—

	At vol.	η.
Magnesium chloride	14	1·2015
Cupric chloride	8	1·2050
Manganous chloride	7	1·2089
Nickel chloride	7	1·2055
Cobalt chloride	7	1·2041

It is obvious that for the atomic volumes of the same order of magnitude, the values of η are of the same order of magnitude; and, in general, the larger the atomic volume the smaller the value of η, just as we should anticipate in terms of our hypothesis.

The small values of η for zinc, cadmium, and mercury are probably due to the fact that the salts of these metals are only slightly dissociated.—*American Chemical Journal*, xxxvii., No. 4.

ULTRA-VIOLET LIGHT IN THE LABORATORY AND IN PRACTICE.*

By CHARLES BASKERVILLE.

LENARD, in 1900, noted that ultra-violet light may ozonise oxygen (*Ann. Phys.*, i., 486). The source of this light of short wave-length used by him was a spark-gap, the light being transmitted through quartz. It could be intercepted by sheets of mica.

Three years later, Goldstein, with liquid air, condensed ozone produced outside of Geissler tubes (*Ber.*, xxxvi., 3042). Unless the glass were permeable to the ultra-violet rays—that is, composed largely of quartz—no ozone was obtained.

The next year Warburg (*Ann. Phys.*, xiii., 475) found that during the silent electric discharge, the familiar method for producing ozone in a Siemens tube, ultra-violet light and cathode rays were obtained, and the production of ozone might be attributed to these rays.

This *savant*, in collaboration with Regener (*Sitzungsber. Preuss. Akad. d. Wiss.*, 1904, 1228), used a differential ozonometer with quartz capillary, and learned that not alone was an ozonising influence exercised by the ultra-violet light, but as well a de-ozonising.

Clement has shown that ozone is rapidly destroyed by increase in temperature (*Ann. Phys.*, 1904, xiv., 334). Fischer and Braehmer confirmed this (*Ber.*, 1905, xxxviii., 2633), and by using a quartz mercury lamp for the source of the ultra-violet light, demonstrated beyond question the ozonisation of oxygen under that influence. Manganese glass exposed a few hours to this ultra-violet light acquires the coloration observed in it after long exposure to sunlight.

These writers put forward the suggestion that ozone is formed in the higher portions of the atmosphere by the unabsorbed ultra-violet rays, sinks to lower regions, and is decomposed by oxidisable substances.

Regener (*Ann. Phys.*, 1906, xx., 1033) has determined that ultra-violet light rays of wave-length smaller than 200 $\mu\mu$ produce ozone, whereas the rays with wave-length of about 257 $\mu\mu$ or higher decompose it. Therefore we have a double action of the ultra-violet light. The apparently spontaneous de-ozonisation is similar to that of the influence of the elevation of temperature. An interesting and wide field of investigation is thus opened up for the study of the action of ultra-violet light of different wave-lengths. We have been using a mixture of reagents as it were.

Regener has also shown that the ultra-violet rays of small wave-length decompose ammonia, nitrogen monoxide, and nitrogen dioxide. Many chemical effects now known are manifested under the influence of the silent electric discharge. Nearly all gases and mixtures of gases (except the noble ones) are capable of at least one chemical reaction under its influence. It has been almost demonstrated that the silent discharge is similar to the action of ultra-violet light, and when that is definitely accomplished our knowledge of photographic chemical phenomena will have acquired a much broader field.

Ramsay and Spencer have recently studied some chemical and electrical changes induced by ultra-violet light (CHEMICAL NEWS, 1906, xciv., 77). An electroscope

* A Paper read at the Tenth General Meeting of the American Electro-chemical Society, New York, October 8, 1906.

charged positively is discharged by ultra-violet light; when negatively charged this does not occur. A conclusion was drawn from the work which indicates that elements and compounds, when illuminated by ultra-violet light, discharge corpuscles.

It has long been known that willemite (zinc orthosilicate) phosphoresces under the influence of ultra-violet light. If there be one thing in science that is attractive, it is the seeing of the invisible. Ever since, and even before the days when Cascariolo (in 1602) discovered what is now called "Canton's phosphorus," people have been actively interested in the phenomena of phosphorescence and fluorescence. It may be said to have eventuated in the discovery of radium.

Many natural substances have been found which glow in the dark under various influences. In the course of a prolonged study of the elaborate Morgan-Tiffany collections of gems and minerals in the American Museum of Natural History, Kunz and the writer exposed 13,000 specimens to ultra-violet rays. The light used was obtained by sparking a high-tension current among iron terminals in the lamp devised by Piffard. Only one or two of the many interesting observations will be noted here.

First, in examining the spodumenes, a new pink one obtained from California phosphoresced, showing a marked difference from the other varieties. This was proved to be new, and the beautiful gem has been named "Kunzite" in honour of my colleague in the investigations.

Second, one of the most phosphorescent minerals observed was colemanite. In the examination I was surprised to note that every mineral obtained from Mono Lake phosphoresced. These minerals obtained from other sources varied very much in their conduct. These do not crystallise alike, hence the phenomenon cannot be explained on that basis. They vary widely in their chemical composition, as may be seen from this list:—

Colemanite ..	$Ca_2B_6O_{11}.5H_2O$
Glauberite	$Na_2SO_4.CaSO_4$
Borax	$Na_2B_4O_7.10H_2O$
Polyhalite	$2CaSO_4.MgSO_4.K_2SO_4.2H_2O$
Halite	$NaCl$
Celestite	$SrSO_4$
Thenardite . ..	Na_2SO_4
Gypsum	$CaSO_4.2H_2O$
Hanksite	$4Na_2SO_4.Na_2CO_3$
Northupite . ..	$MgCO_3.Na_2CO_3.NaCl$
Pirssonite	$CaCO_3.Na_2CO_3.2H_2O$

Investigators of phosphorescent substances prepared in the laboratory have proved the need of some impurity in the material or the presence of something other than that looked upon as necessary to produce the actual chemical compound. This has been done in the case of the phosphorescent sulphides. Mr. Bourgougon, of this laboratory, has prepared willemite, pure zinc orthosilicate, and it does not phosphoresce, but with the addition of manganese and other metallic oxides in small amounts, splendid artificial willemite has been made. Humphreys has found the yttria earths in the fluorspars, and I have noted that chlorophane, the most responsive of all these fluorides, contains nearly 1 per cent of the yttria earths.

Someone has said that prophecy is the most gratuitous mistake, but to my mind there must be something not recognised in the ordinary analyses of those minerals from Mono Lake, and from them may come an element for a vacant place in Mendeleeff's table.

The artificial wollastonite (calcium metasilicate), and the pseudo-wollastonite made by Day and Allen show a marked difference under the influence of the ultra-violet light. The pseudo-wollastonite glows in the dark and may be readily separated from the normal preparation.

On account of the brilliant response willemite gives to the ultra-violet light, at my suggestion it has been placed in the concentrating rooms of the New Jersey Zinc Co., where large quantities of that mineral are prepared for the furnace daily. A perfect control is thus had over the waste in the tailings.

We frequently use the lamp in the laboratory for the examination of precipitates, before and after burning. I am inclined to think it will serve a greater purpose, as has been indicated.

THE ACTION OF SODIUM ON ACETONE.*

By RAYMOND FOSS BACON and PAUL C. FREER.

(Concluded from p. 246).

Experiment 8.—Four grms. of diatetone alcohol were dissolved in 20 cc. of ethyl alcohol and 20 cc. of water. The solution was saturated with sodium acetate and 4 grms. of semicarbazide hydrochloride were added. The solution was then rendered very faintly alkaline, and placed in ice-water for one hour, being vigorously scratched with a glass rod. No precipitate appeared. To be sure that the conditions were correct for the formation of a semicarbazone, the solution was divided into two equal portions. To portion number two, 2 grms. of acetone were added, whereupon a precipitate of crystalline needles immediately appeared. Four grms. of semicarbazide hydrochloride were now added to this portion of the original solution, so that a sufficiency of the reagent should be present to precipitate all acetone and all diacetone alcohol, should it form a semicarbazone. Both the original, unchanged portion and the second one were kept in the ice-chest overnight. In the morning, portion number one, to which no acetone had been added, contained a very faint precipitate (0·01 grm. melting at 185° to 186°, it being acetone semicarbazone), so that a very small amount of acetone had been separated by hydrolysis. From portion number two, 2·5 grms. of acetone semicarbazone were isolated, melting at 186°.

From the above result it is evident that the acetone semicarbazone obtained in the preceding experiments could not have originated in the sodium derivative of diacetone alcohol, as the hydrolysis of the latter body is a time reaction which proceeds slowly.

The above results confirm the previous work in every way, and establish the fact that the action of sodium on acetone gives a sodium derivative which can only be sodium acetone.

In view of the above conclusions it is not deemed necessary further to discuss Miss Taylor's results, as, apparently, she had not reproduced the conditions under which Freer worked. A very short review of some of the chief facts established in the earlier literature, and which Miss Taylor appears not to have considered, may not be out of place, as it will serve to recall some of the arguments which were not discussed in Miss Taylor's paper. The portion of the product of the action of sodium on acetone which is insoluble in ether was shown by Freer (*Am. Chem. Journ.*, 1893, xv., 592) to consist of acetone sodium, sodium isopropylate, and disodium pinaconate, the soluble portion, of a sodium derivative of acetone; no sodium isopropylate was isolated from this soluble portion, and, if it is not carefully acidified, mesityl oxide and phoron are to be obtained. In studying the products of the action of chlorcarbonic ether on sodium acetone, Miss Taylor suggests that a mixture of ethyl isopropyl carbonate and diethylcarbonate would yield 34 per cent of carbon dioxide, whereas Freer found 33·89 per cent on decomposing the oil boiling between 128° and 129°, and produced by the interaction of sodium acetone and chlorcarbonic ether (calculated CO_2 for $C_6H_{10}O_3$, 33·84 per cent), but Miss Taylor appears to have overlooked the statement that Freer also proved the presence of ethyl alcohol and *acetone* in the products left after saponification (*Ibid.*, 1891, xiii., 325). If acetone had been present as mesityl oxide,

* From the *Philippine Journal of Science*, ii., No. 1.

the percentage of carbon dioxide would have fallen very much. It was further shown by Freer that the fraction boiling at 128° yielded a sufficient amount of acetone on decomposition with dilute acid to allow of its being separated as the acetone sodium-bisulphite compound (*Ibid.*, 1895, xvii., 11). (Found, carbon dioxide, 33·7 per cent; the quantity of ethyl alcohol was less than one-half the organic liquid isolated, it boiled at 78°). We would therefore, if we were dealing with a mixture of diethylcarbonate, ethyl isopropyl carbonate, and mesityl oxide, need to assume a large proportion of the latter substance to be present, and this would inevitably have lowered the carbon dioxide very markedly. Furthermore, the oil boiling between 132° and 137° yielded 30 per cent of *acetone* (calculated 48·8 per cent), and this figure, because of the difficulties in quantitative estimation, is undoubtedly too low. It does not seem reasonable to assume that an oil which would contain a sufficient quantity of mesityl oxide to yield so much acetone would not further react with phenylhydrazine, but, on the other hand, this percentage would correspond to a total of 62 per cent of the isoacetone ester in the oil. Miss Taylor's supposition is that this acetone comes from mesityl oxide present in the mixture. If enough mesityl oxide occurred in the mixture to yield 30 per cent of acetone, then the carbon dioxide found would be reduced by 11 per cent, to say nothing of the change brought about in the analytical results. A mixture which consists of ethyl isopropylcarbonate, diethylcarbonate, and sufficient mesityl oxide to yield 30 per cent of acetone, and which will also give 33·7 per cent of carbon dioxide, can not be calculated. Miss Taylor allowed her reaction product to stand over phenylhydrazine for four days. It is possible that, if isopropenylethylcarbonate was present at all, it would by that time have reacted with phenylhydrazine; it is also possible that, owing to some variation in her work, Miss Taylor never had the body in the oil she prepared. Attention is further called to the fact that Freer obtained enough 2-chlorpropene by the action of phosphorus pentachloride to isolate this very low-boiling substance. The reaction product also absorbs bromine in the cold, without yielding hydrobromic acid.

Miss Taylor did not use benzoyl chloride in studying the composition of sodium acetone, substituting *p*-nitrobenzoyl chloride therefor. Again, in her reactions she does not seem to have had a sodium derivative which acted like the one described above, for she obtained *none of the addition products* described by Freer as a result of the action of benzoyl chloride on sodium acetone. That *p*-nitrobenzoyl chloride might not form an isoacetone ester is conceivable, but in that event it *should* give addition products. Freer, in studying the action of benzoyl chloride on sodium acetone separated the reaction products into two parts, one soluble in alkalis, the other insoluble. In this instance, the insoluble oil (12 grms.) boiling at 120° (39 mm. pressure) added bromine in the cold, gave acetone in sufficient quantity to be isolated from the sodium-bisulphite compound, isopropyl alcohol, and ethyl alcohol. The organic liquid containing the acetone was twice as great in volume as the remainder. The portion of the reaction product which was soluble in alkalis yielded acetophenon, *mono-*, and *dibenzoyl* acetone. Here we are not dealing with a mixture of oils, but with crystalline solids which can be isolated in the pure state. It is difficult to see how mono- and dibenzoyl acetone could result from a mixture of condensation products of acetone, sodium isopropylate, and caustic soda. Sodium acetone must have taken part in the reaction.

It should also be remembered that Freer and Lachman (*Am. Chem. Journ.*, 1897, xix., 878) studied the action of sodium on methyl propylketone, obtained 22·1 per cent of sodium in the derivative (calculated, 21·3 per cent), isolated dibenzoyl methyl propylketone, and from 2 grms. of the alkali insoluble portion obtained 0·9 grm. benzoic acid, 1 grm. methylpropylketone, some halogenated oil, and some hydrochloric acid. The entire 2 grms. is therefore accounted for. Intermediate halogenated addition products were also demonstrated.

Pure mesityl oxide reacts so energetically with sodium that the products may take fire with explosive violence, the sodium compound is so unstable that it can not be isolated.

From the above considerations it is evident that the original descriptions of sodium acetone remain unaltered.

Note.—Since the above was written an article by Levi and Voghera (*Gazz. Chim. Ital.*, 1905, xxxv., I., 277) has come to our attention. These investigators studied the electrolysis of KSCN, KI, and NaI in acetone solution, water being rigidly excluded from their solutions. At the cathode sodium acetone respectively potassium acetone separated as white substances. With water these gave acetone and sodium, or potassium hydroxides. The potassium acetone gave 40·70 per cent of potassium (calculated, 40·62 per cent), and it dissociated, when placed in water, into acetone, potassium, and hydroxyl ions, the correct lowering of the freezing-point for a molecular weight of 96 was obtained (found, 95·3).

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

Part II.—Analysis of the Silver, Copper, and Tin Groups.

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 244).

Analysis of the Tin Group.

Procedure 41.—Dilute in a small flask the first portion of the ammonium sulphide solution (P. 22) with about 20 cc. water, make it distinctly acid with HCl, and warm it slightly for five minutes with frequent shaking to coagulate the precipitate. (Fine, not flocculent, white or pale yellow precipitate, absence of *tin group*; deep yellow or orange flocculent precipitate, presence of *tin group*). Treat the second portion of the ammonium sulphide solution (P. 22) in the same way, and unite the precipitate, if considerable in amount, with the first one. Filter out, and wash the precipitate, using suction, finally sucking it as dry as possible. (Precipitate, P. 42; filtrates, reject).

Notes.

1. Much time is saved by determining at this point whether or not any element of the tin group is present. When ammonium monosulphide has been used, there is usually no difficulty in drawing a definite conclusion in regard to this from the size and appearance of the HCl precipitate; for in the absence of the tin group only a very small, nearly white precipitate of finely divided sulphur separates. When, however, ammonium polysulphide has been used, it may not be possible to decide as to the presence or absence of a small quantity (1 to 5 mgrms.) of arsenic, antimony, or tin; for not only is a fairly large precipitate of sulphur then obtained, but it may be darkened in colour by the presence of CuS or HgS; yet when the precipitate is nearly white, and finely divided or granular, the conclusion can be drawn at once that no element of the tin group is present in quantity as large as 1 mgrm.; and when it has a pronounced yellow colour (indicating arsenic or tin) or an orange-red colour (indicating antimony) the conclusion can be drawn that one of these elements is present. In this connection it may be mentioned that a mixture of SnS_2 and Sb_2S_5 does not always have a colour intermediate between those just mentioned, but may be brown or dark grey.

2. When, however, the HCl precipitate from a polysulphide solution is fairly small, and is dark brown (indicating copper), or dark grey or black (indicating mer-

* From the *Technology Quarterly*, xix., No. 3, September, 1906.

cury or one of the rarer elements), or of unpronounced yellow or orange colour. so as to make any conclusion as to the tin group doubtful, the precipitate is best treated as follows:—Heat it with 15 to 20 cc. NH_4OH (0·96) almost to boiling for five minutes, and filter; test the precipitate for copper by P. 23, 28, and 30 if it has not already been found present; add to the filtrate a few drops of ammonium monosulphide, filter out any precipitate, heat the filtrate to boiling, make it acid with HCl, shake, filter out the precipitate, and treat it by P. 42 as usual. The character of the HCl precipitate thus obtained will clearly indicate the presence or absence of the tin group; for by the treatment with NH_4OH the excess of sulphur originally present and any CuS is left undissolved, and by the $(NH_4)_2S$ added to the solution any mercury present is precipitated, so that the HCl precipitate can contain only sulphides of the tin group and a very little sulphur. As_2S_5, Sb_2S_5, and SnS_2 all dissolve in NH_4OH (though in the cases of Sb_2S_5 and SnS_2 less abundantly than in ammonium sulphide), owing to the formation of a mixture of salts of the intermediate sulpho-acids, such as H_3AsO_3S and $H_3AsO_2S_2$. The addition of $(NH_4)_2S$ to the NH_4OH solution, and the heating serve to convert these into more highly sulphurated acids, from which HCl will then precipitate the simple sulphides completely. The incidental removal of the small amounts of CuS and HgS by the NH_4OH treatment is not necessary as far as the analysis of the tin group is concerned, since their presence does not interfere with the detection of even 1 mgrm. of arsenic, antimony, or tin; but it does enable 1 or 2 mgrms. of copper to be detected which might otherwise be lost.

3. When the HCl is added to the solution of the sulpho-salts, the corresponding sulpho-acids which are liberated decompose immediately into H_2S and the solid sulphides, which are now necessarily in the higher state of oxidation, since the lower sulphides, if originally present, have been oxidised by the polysulphide. The fact that the sulpho-acids decompose while the sulpho-salts are stable is a consequence of the Mass Action Law, which, when applied to the dissociation of the complex anions taking place according to the equations, $SnS_3^{=} = SnS_2 + S$, $2AsS_4^{\equiv} = As_2S_5 + 3S^{=}$, $2SbS_4^{\equiv} = Sb_2S_5 + 3S^{=}$, evidently requires that these decompose to a greater extent into the un-ionised sulphides (SnS_2, &c.) the smaller the concentration of the $S^{=}$ ion in the solution. Now in the solution of the largely ionised $(NH_4^{+})_2S^{=}$ there is a fairly large concentration of $S^{=}$ ion; but when the solution is made acid with HCl, the $S^{=}$ ion is, for the most part, converted by the relatively large concentration of the H^{+} ion into the slightly ionised substances HS^{-} and H_2S; and, consequently, the concentration of the un-ionised sulphides in the solution becomes great enough to exceed the solubility value, and the solid sulphides separate out.

Procedure 42.—Transfer the precipitated sulphides dried by suction (P. 41) to a wide test-tube, add from a small graduate exactly 10 cc. HCl (1·20), and heat nearly but not quite to boiling (preferably by immersing the test-tube in hot water or on a steam-bath) for about ten minutes with frequent stirring. Add 5 cc. water from a graduate containing 40 cc. water, filter, wash once with about 5 cc. water from the graduate, collecting this wash-water with the filtrate; remove the filtrate, and add to it the water remaining in the graduate; wash the residue with HCl (1·12). (Residue, P. 43; filtrate, P. 45).

Notes.

1. If a much weaker HCl solution than the acid of specific gravity 1·20 is used, or if the acid becomes diluted by an unnecessary quantity of water left in the precipitate, much Sb_2S_5 will be left undissolved. Even with the strong acid some Sb_2S_5 may remain undissolved, especially when a large quantity is present, in which case the residue if small in amount will have an orange colour. This small quantity of Sb_2S_5 would be only very slowly removed by further treatments with HCl; it does not, however, interfere with the subsequent tests for arsenic. Moreover, when only a small quantity of Sb_2S_5 is originally present, a large proportion of it is extracted, so that it will not escape detection. Sb_2S_5 dissolves with formation of $SbCl_3$ and liberation of sulphur; SnS_2 with formation of $SnCl_4$.

2. If the solution be kept just below the boiling-point during the treatment with HCl, the amount of As_2S_5 which dissolves in ten minutes is insignificant; but this is no longer true if the solution be allowed to boil, for the boiling rapidly expels from the solution the H_2S liberated from the other sulphides or by slight decomposition of the As_2S_5 itself, and thus enables the decomposition of the latter to proceed further.

3. As_2S_3 is more rapidly dissolved by HCl than is As_2S_5. If the former can be present in the precipitate, which can occur only when HNO_3 or aqua regia was not used in dissolving the original substance, and if ammonium monosulphide was employed for separating the copper and tin groups, the procedure should be modified as follows:—After the addition of HCl to the sulphides saturate with H_2S in the cold, and then heat nearly, but not quite, to boiling for ten minutes, passing a slow current of H_2S gas through the mixture. Under these conditions scarcely any As_2S_3 dissolves.

4. About 5 cc. water are added to the HCl solution to enable it to be filtered. If more be added, and the H_2S has not been completely expelled from the solution, a precipitate of Sb_2S_3 may separate. If this happens after the filtration, it does, of course, no harm.

5. Care must be taken to follow closely the directions in regard to the quantities of HCl and water used; for the subsequent separation of antimony and tin (P. 45) depends upon a proper concentration of the acid.

6. The greater part of any CuS and HgS present will be dissolved by the HCl, and will be precipitated later with the Sb_2S_3 (P. 45). A little remains with the As_2S_5, but this does not interfere with the tests for arsenic. *Of the precipitates of the rarer elements, PtS_2, Au_2S_3-6, Se, and MoS_3 are dissolved by the HCl scarcely at all, and TeS_2 only to a small extent. The dissolving of the last, like that of As_2S_3, can be entirely prevented by passing a slow current of H_2S through the hot HCl solution.

Procedure 43.—Warm the residue from the HCl treatment (P. 42) with 5 to 10 cc. HCl (1·12) adding solid $KClO_3$ in small portions until the reaction is complete; filter off the sulphur, and evaporate the solution to about 2 cc. [If the solution is still distinctly yellow, or if a yellow precipitate has separated, test for and remove platinum by *P. 43*a*, and treat the filtrate as follows]. Add NH_4OH gradually until the solution after shaking smells of it; cool, filter off, and reject any precipitate. Add to the filtrate about one-third its volume of NH_4OH (0·90), and several drops of magnesium ammonium chloride reagent, and shake. If no precipitate appears, rub the walls of the test-tube gently with a glass rod for a minute or two. (White crystalline precipitate, presence of *arsenic*). Collect the precipitate on a filter, and wash it once with NH_4OH (0·96). (Precipitate, P. 44; filtrate reject, or test for gold, selenium, tellurium, and molybdenum, by *P. 43*b*).

Notes.

1. The main reaction between $KClO_3$ and concentrated HCl is the formation of Cl_2; the yellow colour results from the formation of a small proportion of chlorine dioxide, ClO_2.

2. As_2S_5, though only very slowly dissolved by HCl alone, is dissolved rapidly by it in the presence of Cl_2, because of the destruction of the H_2S, one of the reaction products, by oxidation. It is dissolved with formation of

H_3AsO_4; $AsCl_5$ has never been shown to exist. When, as here, arsenic is present in the higher state of oxidation, solutions of it may be boiled without loss of an amount of arsenic significant in qualitative analysis.

3. A white precipitate, obtained on adding NH_4OH may arise from the presence of mercury. The NH_4OH solution may contain not only arsenic, but also certain rare metals, and the small quantities of copper (if ammonium polysulphide was used), antimony, and stannic tin that were not dissolved out of the sulphide precipitate by HCl.

4. The test for arsenic depends on the formation of magnesium ammonium arsenate, $Mg^{++}(NH_4)^{+}AsO_4^{\equiv}$. This salt is somewhat soluble in water, and therefore the solution tested should be fairly concentrated. Owing to hydrolysis (into NH_4OH and $Mg^{++}HAsO_4^{=}$), the precipitate is much more soluble in water than in a strong NH_4OH solution; hence the addition of a large quantity of the latter. Like other crystalline precipitates, it tends to form a supersaturated solution. Precipitation is promoted by agitation, by rubbing the walls of the tube with a glass rod, and by increasing the degree of supersaturation, which is done by concentrating and adding NH_4OH. Provided these precautions are taken and the total volume of the final solution does not exceed 5 cc., the presence of even half a mgrm. of arsenic can be detected. Care must be taken not to scratch the glass by violent rubbing, since the powdered glass may be mistaken for the $MgNH_4AsO_4$ precipitate.

5. The magnesium ammonium chloride reagent contains $MgCl_2$ and NH_4Cl. The presence of the latter salt prevents the precipitation of $Mg(OH)_2$ by NH_4OH, by reducing the OH^- concentration.

**Procedure* 43*a*.—Evaporate the solution of the sulphides in HCl and $KClO_3$ (P. 43) until KCl crystallises out, cool, and add water drop by drop until the KCl just re-dissolves. (Yellow precipitate, presence of *platinum*). Filter, wash the precipitate with a little cold saturated KCl solution, and treat the filtrate by P. 43 to detect and remove arsenic. Dissolve the precipitate by pouring repeatedly a 5 to 10 cc. portion of hot water through the filter, and add to the solution a few drops of KI solution. (Deep red colour, presence of *platinum*).

Notes.

1. Potassium chlorplatinate, $K^{+}{}_2PtCl_6^{=}$, is fairly soluble in water, but much less so in a saturated KCl solution, owing to the common ion effect.

2. The deep red colour formed on the addition of KI to K_2PtCl_6 is due to the formation of K_2PtI_6 in solution. When the K_2PtCl_6 is present in excess a black precipitate of PtI_4 separates, but this dissolves readily on further addition of KI.

**Procedure* 43*b*.—To the filtrate from the $MgCl_2$ precipitate (P. 43) add 2 to 3 cc. saturated oxalic acid ($H_2C_2O_4$) solution, and evaporate in a casserole to 3 to 4 cc. to expel the excess of ammonia. Make the solution slightly acid with $H_2C_2O_4$, if it is not already so, add about 10 cc. water, and digest on a steam-bath for several minutes. (Purple precipitate, presence of *gold*). To the mixture add 2 to 3 cc. HCl (1·12) to dissolve any tellurium hydroxide, and filter. (Precipitate, reject; filtrate, *P. 43*c*).

Notes.

1. Metallic gold is precipitated readily from a solution of ammonium oxalate only when the solution is hot and slightly acid; but even under these conditions the precipitation is complete only after several minutes. If these conditions are not realised, several mgrms. of gold may escape detection.

2. The more powerful reducing agents, H_2SO_3 and $SnCl_2$, also precipitate gold, but they reduce selenium and tellurium (and mercury) compounds as well.

**Procedure* 43*c*.—Evaporate the filtrate from the $H_2C_2O_4$ precipitate (*P. 43*b*) almost to dryness, add 10 cc. HCl (1·12), and filter off any KCl that has separated. Collect the filtrate in a test-tube, add about 0·2 grm. solid Na_2SO_3, and allow the mixture to stand for at least five minutes, adding more Na_2SO_3 if the SO_2 odour disappears. (Red precipitate, presence of *selenium*). Filter. (Precipitate, reject; filtrate, *P. 43*d*).

Notes.

1. By the action of H_2SO_3 on selenous acid (H_2SeO_3) in the cold a voluminous red precipitate of selenium is quickly formed; but the reaction is complete only after several minutes. When the solution is hot the more compact black modification of selenium is obtained; but the test is then less delicate and less characteristic.

2. Tellurium is reduced by H_2SO_3 in moderately dilute HCl solutions, but not at all when the concentration of the acid is as great as that of specific gravity 1·12. Selenium, however, separates completely from a more concentrated acid, as well as from a more dilute one. For these reasons, though a greater concentration of HCl is unobjectionable, a lesser concentration would cause the precipitation of tellurium and obscure the selenium test.

**Procedure* 43*d*.—Dilute the filtrate from the H_2SO_3 precipitate (P. 43*c*) with an equal volume of water, and add a few drops of KI solution and a little solid Na_2SO_3. (Black precipitate, presence of *tellurium*). Filter after a few minutes. (Precipitate, reject; filtrate, *P. 43*e*).

Notes.

1. As stated in *P. 43*c*, N. 2, tellurium is precipitated by H_2SO_3 alone when the HCl solution of specific gravity 1·12 is diluted somewhat with water, especially if the mixture is kept hot. The precipitation, however, is much more rapid, and is complete after a few minutes even in the cold if KI is also present. KI alone does not reduce tellurium compounds, but precipitates black TeI_4, which dissolves somewhat in excess of KI, forming a deep red solution of K_2TeI_6. The advantage of adding KI is that the iodine compound of tellurium is more rapidly reduced by H_2SO_3 than is the chlorine compound or tellurous acid itself.

2. Selenous acid is immediately reduced to selenium by KI in HCl solution; but this element is completely precipitated by H_2SO_3 in *P. 43*c* if the directions there given are followed; even if not so removed, it would give a red precipitate, not a black one.

3. Molybdic acid by this treatment is also slowly reduced to a lower compound, which remains in solution. Iodine may thereby be liberated and even precipitated after all the H_2SO_3 has been oxidised. For this reason the solution should not be allowed to stand for more than half-an-hour before filtering.

**Procedure* 43*e*.—Boil the filtrate from the KI precipitate (*P. 43*d*) until the SO_2 is expelled, cool the solution, add 3 or 4 cc. 10 per cent KCNS solution and some granulated zinc. (Red colour, presence of *molybdenum*). [If it is desired to form a better estimate of the quantity of molybdenum present, treat the solution as described in N. 4].

Notes.

1. The H_2SO_3 is boiled out, since otherwise sulphur would be precipitated by the action of zinc.

2. The red colour is due to the formation of $Mo(SCN)_4$, corresponding to MoO_2, an intermediate stage in the reduction of molybdic acid (H_2MoO_4) by the zinc. The colour may appear before the addition of zinc, since the H_2MoO_4 may have already have been partially reduced by H_2SO_3 and HI. Long continued action of zinc causes the red colour to disappear; for the chloride, $MoCl_3$, corresponding to the oxide, Mo_2O_3, to which H_2MoO_4 is finally reduced, gives a colourless solution with KCNS.

3. Ferric salts also give a red colour with KCNS; but a coloration arising from the presence of iron as an impurity disappears almost immediately on the addition of zinc, owing to reduction to the ferrous state.

4. It is difficult from the depth of the red coloration to form an estimate of the quantity of molybdenum present. The molybdenum may be obtained in the form of a precipitated sulphide by treating the solution to which KCNS and zinc have been added as follows:—Add a little solid $KClO_3$, and boil to re-oxidise the molybdenum, and finally to expel the chlorine, adding more HCl (1·20), if necessary; pass H_2S into the solution for ten minutes, keeping it near the boiling-point.

Procedure 44.—Dissolve the $MgCl_2.NH_4Cl$ precipitate (P. 43) by pouring a little HCl (1·12) through the filter, heat the solution obtained nearly to boiling, and pass in H_2S for at least five minutes, keeping the solution hot. (White precipitate turning yellow, presence of *arsenic*). (Precipitate and solution, reject).

Notes.

1. The slow formation in a dilute acid solution of a pale yellow precipitate with H_2S is a characteristic test for H_3AsO_4. The precipitate is a mixture of As_2S_5, As_2S_3, and sulphur, the amount of As_2S_5 being comparatively small in the presence of strong HCl and at high temperatures.

2. A considerable amount of H_2S may be absorbed by a dilute H_3AsO_4 solution before any precipitate appears. This is due to the formation of H_3AsO_3S, which then decomposes slowly, giving H_3AsO_3 and sulphur. This last decomposition may be accelerated by increasing the H+ concentration, and by raising the temperature. The H_3AsO_3 formed reacts at once with H_2S, and As_2S_3 is precipitated. The reactions taking place are, therefore, $H_3AsO_4 + H_2S = H_3AsO_3S + H_2O$, $H_3AsO_3S = H_3AsO_3 + S$, $2H_3AsO_3 + 3H_2S = As_2S_3 + 6H_2O$, which together give the reaction—

$$2H_3AsO_4 + 5H_2S = As_2S_3 + S_2 + 8H_2O.$$

The rate of this reaction depends upon the rate of the slowest of the single reactions—the decomposition of H_3AsO_3S. As_2S_5 is produced by an independent reaction, $2H_3AsO_4 + 5H_2S = As_2S_3 + 4H_2O$, which takes place very slowly.

Procedure 45.—Heat the solution of the sulphides (P. 42), which should contain 10 cc. HCl (1·20) in a total volume of 50 cc., to about 90°, and pass in H_2S gas for about five minutes, keeping the solution at about 90°. If no precipitate appears, add about 5 cc. water, and again saturate with H_2S at the same temperature as before. (Orange-red precipitate, presence of *antimony*). Filter while hot, add 5 cc. water, heat the filtrate nearly to boiling, again saturate with H_2S to ensure complete precipitation of antimony, and filter if any precipitate forms. Wash the precipitates with hot water. (Precipitate, P. 46; filtrate, P. 47).

Notes.

1. By following carefully the directions given in P. 42 and this procedure, a good separation of antimony and tin may be obtained; when only 1 mgrm. of antimony is present it is precipitated as Sb_2S_3, while even 500 mgrms. of (stannic) tin give no precipitate. If, however, the HCl solution be too concentrated, a small quantity of antimony will escape detection; hence the precaution of adding a little water to the solution and repeating the treatment with H_2S. If the HCl solution be too dilute, or if it be not kept hot, some SnS_2 may precipitate when a large amount of tin is present. When mixed with a little Sb_2S_3 a brown precipitate results.

2. If mercury or copper be present in the substance and ammonium polysulphide has been used, HgS or CuS may be precipitated at this point as a grey or black precipitate.

Procedure 46.—Dissolve the H_2S precipitate (P. 45) in a little strong HCl in a small casserole, and evaporate the solution to about 1 cc. Introduce beneath the solution a piece of platinum-foil, and place upon it a piece of pure tin. After several minutes wash carefully with water, and cover the platinum-foil with (alkaline) NaOCl solution. (Black deposit on the platinum undissolved by NaOCl, presence of *antimony*). Precipitate and solution, reject).

Notes.

1. Mercury and copper, if present, will also be precipitated in the metallic condition upon the platinum, but the antimony may be easily distinguished from them by its black colour. Tin is used rather than zinc in precipitating the antimony, since zinc would also precipitate tin from the solution.

2. The treatment with NaOCl serves to prove that the black precipitate does not consist of arsenic or tellurium; for these elements are readily dissolved by it, while antimony is not. Since, however, several mgrms. of arsenic must be present before the treatment with tin would give a deposit on the platinum, an arsenic deposit will probably never be obtained in an actual analysis.

Procedure 47.—Cool the filtrate from the H_2S precipitate (P. 45), dilute with 20 cc. water, and pass in H_2S for ten minutes. (Yellow precipitate, presence of *tin*). If there is a precipitate, evaporate the mixture without filtering to 5 to 10 cc., add about 1 grm. of granulated zinc, and allow the action to continue for several minutes, but not until all the zinc is dissolved. (Grey, spongy precipitate, presence of *tin*). Decant the solution into a test-tube, allow any particles suspended in it to settle out, decant again, and unite the two residues. Heat the residues with 2 to 5 cc. HCl (1·20) until everything (except any particles of carbon is dissolved. Dilute the solution with one-half its volume of water, and pour it at once through a small filter into 5 cc. $HgCl_2$ solution. (White precipitate, presence of *tin*).

Notes.

1. The solution is precipitated with H_2S in the cold, because a small quantity of SnS_2 would not separate from a hot solution unless the acid were more diluted. The addition of much water is avoided, since it has to be evaporated off in the confirmatory test.

2. In the confirmatory test the precipitate of SnS_2 is not filtered off, but is dissolved by concentrating the acid by evaporation, since it clogs the filter and tends to pass through it. The zinc must not be allowed to dissolve entirely, since the tin might then also dissolve. Care must also be taken not to lose it in the process of decantation or by failing to dissolve it completely. Finally, since $SnCl_2$ oxidises rapidly in the air, the solution in HCl must be immediately added to the $HgCl_2$ solution. If these precautions are observed, the presence of half a m.grm. of tin in the HCl solution of the sulphides (P. 4) may be detected after some practice. The confirmatory test is, however, less delicate than the precipitation by H_2S, but it is more characteristic, since $SbCl_3$, even if present, does not reduce $HgCl_2$.

(To be continued).

Chemistry and Photographic Exhibition.—The above Exhibition, which is being held in Gamage's Main Bazaar Hall, opened on Monday, May 27, and will remain open till Saturday, June 8. It is open from 9 a.m. to 8 p.m.; Saturdays, 9 a.m. to 5 p.m. Admission is free. Stands have been fully taken up by leading manufacturers.

Constitution and Properties of Boron Steel.—Léon Guillet.—Normal boron steels consist of a solid solution of iron and boron, containing very little boron, perlite, and a special substance which seems to be a boro-carbide of iron, containing only a little carbon. This last compound seems to make the steel very brittle, but this effect disappears after tempering, when the substance itself dissolves.—*Comptes Rendus*, cxliv., No. 19.

THE RAPID DETERMINATION OF NICKEL IN STEEL.*

By Dr. GEORGE T. DOUGHERTY, Chicago, Ill.

FOR the past ten years the quickest standard method generally used, at least in the United States, for the determination of nickel in steel has been by making, as a preliminary step, a separation of the mass of the iron from nickel by means of ether and then repeating the process. This method was probably first described by G. H. Chase, of Philadelphia, and was a distinct advance toward simplified and rapid nickel analysis. What small quantity of iron remains along with the nickel after the two ether treatments is finally removed by ammonia, and a great many chemists make a second precipitation of this iron with ammonia to make sure that all the nickel is saved for a determination. These many operations with repetitions necessarily take a good deal of the busy analyst's time. It seems to be the fashion with many to prolong the work by evaporating to dryness the preliminary solution of the sample and to take up and filter off the silica, when all this is unnecessary and superfluous, especially when nickel in solution is to be finally titrated with potassium cyanide solution.

The separation with ether cannot very well be applied to the analysis of ores of the kinds usually carrying nickel, owing to the presence of sulphuric acid, which has displaced the other acids used in decomposing the ore at the start. The standard method for ores, therefore, is to make two precipitations with ammonia and one basic acetate precipitation. Basic acetate separations are usually tedious affairs, and with many persons rather difficult and not uniformly successful, besides imposing an unwieldly quantity of liquid on the operator's hands to filter and handle.

The Use of Ammonia.

The ether method for nickel in steel, when all essential details are properly and carefully attended to, makes for highly accurate results. However, not being quite satisfied with it on account of the time required, I began experiments under different conditions with ammonia and ammonium chloride for separating nickel from iron. These require many months' time to go thoroughly into the subject. Many chemists of repute one after another tried the ammonia treatment and were disgusted with the results, which would show only 20 to 70 per cent of the quantity of the nickel known to be present. One writer of international note says that it takes at least six precipitations with ammonia to get out all the nickel. They always ascribed their failures to the absorption of nickel by the ferric hydrate precipitate. It occurred to me that perhaps they had not used quite enough ammonia or ammonium chloride or both.

To start the experiments I had nickel steels of known nickel contents, which I had determined carefully by using the standard ether method, and finally titrating with potassium cyanide solution. The idea was to try with successively larger quantities of hydrochloric acid, subsequently neutralised by ammonia, to form ammonium chloride and different quantities of free ammonia in excess after neutralisation. For example, I began with 15 cc. of hydrochloric acid added to the solution of 1 grm. of nickel steel solution in one test; 25 cc. in the next; 50, 75, and finally 100 cc. hydrochloric acid, and tested the filtrate each time by titrating with potassium cyanide, running all tests in duplicate or more. In view of the numberless failures reported with ammonia and ammonium chloride for a complete separation of nickel, all I could hope for was to find a minimum quantity of ammonium chloride and ammonia which will separate the largest percentage of nickel present, and under similar conditions will yield a fairly constant percentage of this element present. On the basis of the average results thus obtained I could build up a proper correction to be added to the actual figures obtained in analysis, and thus approximate the true result as closely as possible. It was therefore an agreeable surprise when I finally discovered that 100 cc. strong hydrochloric acid (plus 10 cc. acid used in dissolving the steel), subsequently neutralised with ammonia (or its equivalent, 75 grms. of ammonium chloride) and 50 cc. free ammonia added in excess, after carefully neutralising the solution, will make a perfect and complete single separation, leaving no trace of nickel in the ferric hydrate precipitate. To save the time and labour of washing the bulky iron precipitate, the liquid—after precipitating with ammonia—is diluted to 500 cc. and filtered on a large dry filter, and 250 cc. of filtrate is taken for titration. These remarks have reference to 1 grm. of steel weighed off for analyses; that is, 75 grms. of ammonium chloride, or its equivalent of hydrochloric acid and ammonia, will separate 100 per cent of the nickel present from 1 grm. of steel, and the same proportion of ammonium chloride and ammonia will probably hold good whether for ½ grm. or for 2 grms. of steel, though if 2 grms. of steel were attempted it would become a white elephant on one's hands on account of the double quantities of chemicals, &c., required. Then the 500 cc. volumetric flask would not be large enough to hold all, and a 1000 cc. flask and a larger filter and funnel would have to be used. One grm. of steel is amply sufficient for accurate close results by the new method, though 2 grms. usually are taken when the ether method is used.

The capacity of the new method is considerably above that of the standard ether method. By the former, one can make two or three determinations in the time required for one by the older method. The details of the new method, as finally adopted by myself, are as follows:—

The New Method in Detail.

Dissolve 1 grm. of steel drillings in 15 cc. nitric acid (specific gravity 1·20) in a small beaker and boil one minute. Have ready and hot 270 cc. ammonium chloride solution containing 75 grms. in a 500 cc. common thin glass flask. Pour the steel solution into this flask, adding rinsings from the beaker. Add hydrochloric acid if necessary to clear up, and then ammonia, little by little, until the solution, though practically clear, is so dark from the dissolved ferric hydrate that you cannot quite see through the body of liquid in the flask when you hold it in front of you before the window, the top part being rather more transparent. (This neutralisation is the critical point of the process; a little under neutralising or over neutralising is apt to cause lower results). Cool the flask and contents quickly by running against the glass cold water from the faucet or standing in a vessel. Transfer the contents of this flask, with a little rinsing, into a 500 cc. volumetric flask; add all at once 50 cc. ammonia (sp. gr. 0·90), whirl, and fill up with water to the mark. Shake vigorously to mix thoroughly, and pour through a 10-inch filter in a 4-inch ribbed funnel into a clean dry 600 cc. flask. Take 250 cc. of filtrate (½ grm. of sample), transfer it to a No. 4 Griffin beaker, throw in it a bit of litmus paper, and add sufficient hydrochloric acid (it will take about 25 cc.) to acidify the liquid when litmus paper has turned from blue to red; add ammonia cautiously (about ½ to 1 cc. at a time), stirring with the glass rod until the litmus paper becomes blue again. Take out the litmus paper and rinse it slightly and throw it away. Not more than 1 cc. ammonia in excess is allowable. It is not desirable to allow the litmus paper to remain in the liquid, for when disintegrated by continuous stirring during the subsequent titration its scattered fibres often obscure and render a little uncertain the end-point of the titration. Cool by standing in a large vessel of cold water. When cool, add 5 cc. of silver nitrate solution (0·10 grm. in 200 cc. water, and then 5 cc. of a 2 per cent solution of potassium iodide). Stir and titrate with standard potassium cyanide solution until the very last drop dissipates and destroys the white opacity of the liquid, making it perfectly clear. One can best avoid over-titrating by sitting down and looking horizontally on the body of

* From the *Iron Age*, April 25, 1907.

liquid in the beaker while titrating and stirring. Deduct 0·2 cc. from the burette reading and multiply by 2, and by the titre or nickel factor of the cyanide solution.

If dry ammonium chloride is not in stock it can easily be made up by pouring into a 500 cc. common thin glass flask, wiped dry on the inside, 80 cc. water and 100 cc. strong hydrochloric acid, and with caution and frequent shaking 100 cc. strong ammonia, slanting the flask during the addition. This mixing of hydrochloric acid and ammonia causes a sudden and high rise of temperature (up to 90° or 95° C., nearly boiling hot), and must not be done in volumetric flasks of the usual thick glass, which is not well calculated to withstand extreme changes of temperature and quick cooling under the faucet without liability to crack.

If no particular accuracy of results is required this method may be considerably quickened by having the cold ammonium chloride solution in the 500 cc. volumetric flask when the solution of steel is added to it, and the whole neutralised and precipitated with 50 cc. ammonia and diluted to the mark, or the neutralising is omitted and 55 cc. ammonia at once added to the acid mixture of steel solution and cold ammonium chloride solution. In either modification of the method (neutralising cold and no neutralising attempted) the results are a little irregular and low, falling sometimes as much as ten points under the truth; for example, 3·58 per cent on a 3·68 per cent nickel steel. Scarcely any better results can be obtained by neutralising hot and at once precipitating and filtering while yet hot, and taking 250 cc. of the filtrate after heated back to the same temperature as the 500 cc. liquid had shown on the thermometer at the time of filtering. Only by neutralising hot and cooling the neutralised liquid before precipitating and filtering will the results be uniformly close and fully up to the truth.

(To be continued).

NOTICES OF BOOKS.

Elementary Practical Chemistry. By Frank Clowes, D.Sc. (Lond.), and J. Bernard Coleman, A.R.C.Sc. Fifth Edition. London: J. and A. Churchill. 1907.

The fifth edition of this text-book of elementary practical chemistry is for the first time published in two separate volumes, in order to meet the wishes of many teachers and students. The first volume contains a course of elementary chemistry, such as the student of science should work through before beginning his chemical work. The subject is treated in such an order that an instructive progressive course of lecture work could be founded upon it, and full directions are given for the performance of the practical work, so that the book could quite safely be put into the hands of the beginner. The second volume deals with qualitative analysis, together with some simple quantitative work, both gravimetric and volumetric. A new section on the preparation of pure specimens of metals, their oxides and hydroxides, and salts, gives details of such preparations as the student could with profit carry out at various stages during his course.

Theories of Chemistry. By Svante Arrhenius. Edited by T. Slater Price, D.Sc., Ph.D., F.I.C. London, New York, Bombay, and Calcutta: Longmans, Green, and Co. 1907.

It is impossible to read this book without reflecting that the students of the University of California in Berkeley, before whom the lectures it contains were delivered in the summer of 1904, were singularly fortunate. If merely reading the lectures is sufficient to arouse the interest to a remarkable degree, which will undoubtedly be the experience of all who open the book, it would be difficult to over estimate the enthusiasm aroused when to the charm of the matter and style was added the influence of the personality of the lecturer. The aim of the lectures was to give a complete and coherent account of the development of theories in general chemistry, linking the present with the past, and showing how out of the old grew the new. The book is written in such a style that it can be read with profit by the student whose knowledge does not extend beyond that covered by the average first year course, while to many teachers it will bring fresh ideas or fresh aspects of old knowledge, and all will be struck by the philosophical and liberal spirit displayed in every page. The subjects discussed include the electrical forces between the atoms, the composition of the atoms, and the theory of electrolytic dissociation—one lecture being devoted to objections to this theory and problems connected with it which are still to be solved.

Elektrometallurgie der Eisens. ("The Electro-metallurgy of Iron"). By Dr. Bernhard Neumann. Halle-a-S.: Wilhelm Knapp. 1907.

The author of this monograph has collected enough material relating to the electrical method of extracting iron to enable him to draw very important conclusions as to its practicability. By carefully comparing the technical and economic results of several of the more important processes, he has formed the opinion that in countries such as England and Germany, where the coal supply is abundant and the ores are impure, the electrical method cannot, at any rate under present conditions, hope to compete with the old process. On the other hand, in Canada and South America, where there is a lack of fuel, the iron ores are pure, and water power is easily procured, he believes that the electric furnace method has a great future before it. In order to prove these assertions, he has given in the monograph a complete account of the more important processes which have been patented for the reduction of iron ores by carbon in the electric furnace; beginning with the earliest methods which were suggested, and tracing the development of modern processes. The report of the Canadian Commission is quoted freely, and the preparation of alloys of iron in the electric furnace, which appears to be a rapidly growing industry, is treated fully. The monograph is one of the first to give a complete survey of all the work that has been done in this region and its technical results, and will be found to contain information of great commercial value.

Il Secolo XIX.: La Fisica e l'Elettrotecnica. ("The Nineteenth Century: Physics and Electro-technology"). By Francesco Grassi. Milan: Francesco Vallardi.

In this book the progress which various branches of physics and electro-technology made in the Nineteenth Century is reviewed, in a style which should commend itself to anyone who is contemplating the delivery of popular lectures, or to the youth with a turn for science and an interest in its development. The number of subjects which the author attacks in one volume of moderate size precludes the possibility of his giving more than a superficial account of any of them; but while nothing very new is contained in the book, it has some special features which are worthy of mention. One of these is the illustrations, which are very copious and in some cases peculiarly interesting; for example, the reproductions of old diagrams and pictures, in which the curious contrivances of the early philosophers are shown. The portraits of men of eminence in the scientific world, together with their autographs, also add to the interest of the book, which is a good example of a familiar type of popular work.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Comptes Rendus Hebdomadaires des Stances de l'Académie des Sciences. Vol. cxliv., No. 18, May 6, 1907.

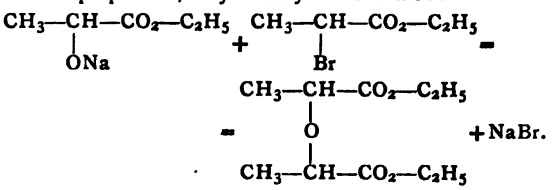
Extension of Friedel and Craft's Reaction.—A. Haller and A. Guyot.—Tertiary aromatic amines, and also certain secondary amines, such as diphenylamine, can condense with a great number of organic molecules in presence of aluminium chloride. According to the conditions under which the reaction is carried out—the temperature, the proportion of aluminium chloride, the excess of one or other of the reagents—different products of condensation are obtained. The yields are generally very high. When indigotin and dimethylaniline are used, the product is $C_{32}H_{30}N_4O$, resulting from the union of one molecule of indigotin with two of dimethylaniline, with the elimination of one molecule of water. The condensation occurs similarly with other reagents, *e.g.*, orthodibenzoyl benzene and dimethylaniline, ethyl phenylglyoxalate and dimethylaniline, &c. In all the cases investigated by the author, with the exception of the oxalic ethers, the molecules contain one or more ketonic or quinonic carbonyl groups, and the aluminium chloride seems to act by fixing the amine molecules on these carbonyl groups, transforming them into tertiary carbinols, $>C<^{OH}_{C_6H_4—NR_2}$, with the subsequent elimination, in certain cases, of one or more molecules of water. Condensations with aluminium chloride often occur when zinc chloride has no action.

Direct Hydrogenation of Carbamines. — Paul Sabatier and A. Mailhe.—When gaseous methylcarbamine, $CH_3.N:C$, is driven by an excess of hydrogen upon reduced nickel kept at 160° to 180°, hydrogenation proceeds regularly. The resulting product, which is condensed in a cooled U-tube, consists chiefly of dimethylamine, and contains also small quantities of ethylamine and diethylamine. When ethyl carbamine, $C_2H_5.N:C$, is hydrogenated in the same way the greater part of the product is methylethylamine, $^{C_2H_5}_{CH_3}>NH$, together with small quantities of propylamine and dipropylamine. The carbamine corresponding to trimethylcarbinol, $(CH_3)_3C.N:C$, when similarly treated, gives the substance $^{CH_3}_{(CH_3)_3C}>NH$, which is a colourless liquid boiling at 58—60° and behaving like a secondary amine. These results show that when the above carbamines are subjected to hydrogenation by means of nickel at temperatures below 180°, one portion polymerises to form tarry products, another portion forms the isomeric nitrile R.CN, which then yields amines, $R.CH_2.NH_2$ and $(R.CH_2)_2NH$, and free ammonia, while the greatest part undergoes the reaction $R.N:C+2H_2=^{R}_{CH_3}>NH$. If the temperature applied is too high (220—250°) much ammonia is produced, and also hydrogen mixed with hydrocarbons.

Absolute Atomic Weight of Bromine.—Gustavus D. Hinrichs.—Baxter found for the atomic weight of bromine Br = 79·952 if Ag = 107·93. But if Ag is taken as the standard, and put = 108, and Br = 80, the ratio Ag + Br : Ag = 1·74074. If Br = 80·1 this value becomes 1·74169, or the change is +95 units of the fifth decimal place for an increase of 0·1 in the atomic weight. Baxter's eighteen determinations give 1·74079, which exceeds the calculated value by five units. Therefore the mean atomic weight exceeds 80 by $5\times\frac{100}{95}=5{\cdot}2$ approximately. Hence Baxter's determinations give for the mean value Br = 80·0052. The difference is lower than the actual degree of accuracy of the determinations, and hence Baxter's work confirms the value 80 for the absolute atomic weight of bromine.

Decahydro-α-naphthylacetone and Decahydro-α-naphthylamine.—Henri Leroux.—Already noticed.

Inactive Dilactylic Acid.—E. Jungfleisch and M. Godchot.—When sodium ethyl lactate is treated with ethyl α-bromopropionate, ethyl dilactylate is formed :—



This dilactylate is saponified by boiling alcoholic soda, forming sodium dilactylate, from which the free acid may be liberated by means of sulphuric acid. When the free acid is distilled, even *in vacuo*, it loses one molecule of water and is transformed into dilactylic anhydride, which is isomeric with dilactide. This method of preparing lactylic acid is general and can be applied to other compounds.

MEETINGS FOR THE WEEK.

MONDAY, June 3rd.—Society of Chemical Industry, 8. "The Nature of, and Changes involved in the Production and Setting of Plaster-of-Paris," by W. A. Davis. "Analysis of White Lead," by W. A. Davis and C. A. Klein. "A Calorimeter for Volatile Liquid Fuel, specially adapted for Petrol," by W. H. Rawles. "Influence of Temperature of Dyeing on Resolution," by W. P. Dreaper and A. Wilson. "Loss of Nitre in the Chamber Process," by J. K. H. Inglis.

— Royal Institution, 5. General Monthly Meeting.

TUESDAY, 4th.—Royal Institution. 3. "Malaria, Sleeping Sickness, Tick Fever, and Allied Diseases," by Prof. G. H. F. Nuttall, F.R.S., &c.

WEDNESDAY, 5th.—Society of Public Analysts, 8. "Horse Fat and 'Animal' Oil," by H. Dunlop. "Method for Determining Caustic Lime in Fertilisers," by J. Hendrick. "Rapid Estimation of Total Solids in Milk," by C. Revis. "The Reducing Action of Hydrogen—III., The Reduction of Molybdic and Vanadic Acids," by A. C. Chapman and H. D. Law.

THURSDAY, 6th.—Royal Institution, 3. "Chemical Progress—Work of Berthelot, Mendeleeff, and Moissan," by Prof. Sir James Dewar, F.R.S., &c.

— — Chemical, 8.30. "Relation between Absorption Spectra and Chemical Constitution - Part VII., Pyridine and some of its Derivatives," by F. Baker and E. C. C Baly. "Interaction of Methylene Chloride and the Sodium Derivative of Ethyl Malonate," by F. Tutin "Molecular Weight of β-Naphthol in Solution in Solid Naphthalene," by E. P. Perman and J. H. Davies. "Synthesis of Hexatriene Derivatives," by I. Smedley. "Constitution of the Diazo-compounds," by J. C. Cain. "p-Cresol Sulphoxide and Sulphide," by S. Smiles and T. P. Hilditch. p-Dioxyphenylsulphoxide," by S. Smiles and A. W. Bain. "Coloured Azo-derivatives of 1 : 3-Diphenylbarbituric Acid—Dynamic Isomerism among the Hydrazones of 1 : 3-Diphenylalloxan," by M. A. Whiteley. "Dibromoaminoazobenzene," by J. T. Hewitt and N. Walker.

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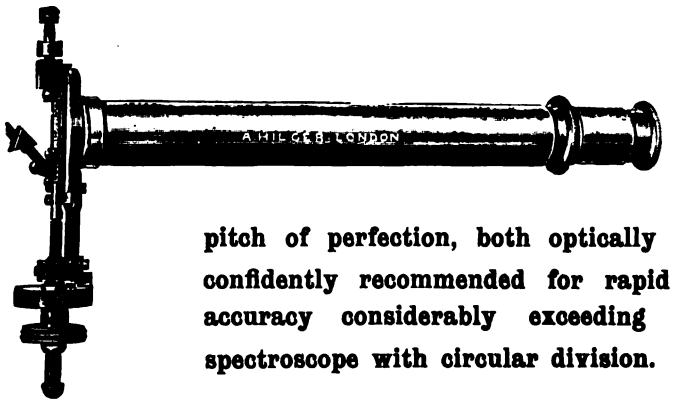

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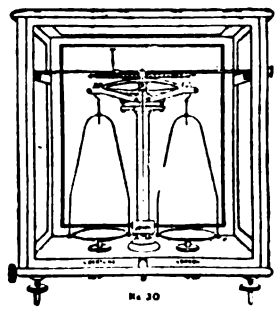

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ON THE THERMO-CHEMISTRY OF FLAME SPECTRA AT HIGH TEMPERATURES.*

By W. N. HARTLEY, F.R.S., D.Sc., Royal College of Science, Dublin.

THE majority of the metallic elements have two distinct spectra, one of lines the other of bands. In some spectra, bands are the most prominent feature in association with but few lines; in others the lines predominate over the bands. Of those substances with bands in their spectra there are many which may be reduced in quantity to almost a minimum without the bands disappearing from the flame or from the uncondensed spark; from this it would appear that there is a very intimate relationship between the bands and lines of the same element. It has been supposed that such bands as cannot be attributed to definite salts are the spectra of oxides or even of hydrides, but many facts have been accumulated from which it is evident that this is not correct. On the other hand, many of the elements which possess complex molecules may readily be understood to emit molecular or band spectra, but some further explanation is necessary when the molecule of the element is monatomic.

The present communication deals only with one part of this subject, being merely a record of observations on high temperature flame reactions, and principally those of the alkali and alkaline earth metals. The spectra of the alkali metals at the highest temperature in the flame of the oxy-hydrogen blowpipe more nearly resemble those obtained from the arc than any other spectra of the same elements. Thus, all the lines of lithium photographed by Kayser and Runge in the arc have been obtained in the flame from lithium nitrate. This is evidence of the high temperature obtainable in the flame, but if further evidence were desired, we have it in the great facility with which both gold and silver can be vapourised and condensed from the vapour, the large number of arc lines of iron, practically all those that are reversible, which appear in the flame, and the volatilisation of palladium and iridium in weighable quantities.

PART I.—BAND SPECTRA OF THE ALKALI AND ALKALINE EARTH METALS.

Lenard (*Ann. der Physik*, 1905, [4], xvii., 197) has recently described the coloured glow emitted by globules of fused salts in the Bunsen flame, the particular parts of the flame from which the glow emanates, with the spectrum of the glow from different metals.

The spectra of the glow from metallic vapours have been photographed repeatedly in the oxyhydrogen flame spectra of all the alkali metal salts ("Flame Spectra at High Temperatures," *Phil. Trans.*, 1894, clxxxv., A, 161), and those of the alkaline earths, but Lenard states that he has not been able to find the maximum of brightness of the continued rays of potassium, at or near λ 5500, as it appears on the reproduction of my photographs (Plates 6 and 7). On referring to the plate, I do not see that the maximum is at λ 5500, and the strong continuous rays are so evenly distributed over so wide a range of spectrum that it is better to refer to the letterpress of the publication.

The continuous spectrum of lithium extended from about λ 4600 to λ 3200; of sodium very strongly from λ 6020 to λ 3600 and continued weakly to λ 3320; of potassium it was intense from about λ 4600 to λ 3400, but continuous rays were observed from about λ 5700. As importance has been attached to the kind of photographic plate used, it is as well to state that isochromatic plates of Edwards's or of the Ilford make, and Cadett and Neall's spectrum plates, were most generally in use, but when the plates were not isochromatic, the fact was recorded on the photograph. On the photograph referred to by Lenard, the plate was less sensitive to the green than to the orange and red rays, so that a weak space is seen between λ 5359 and λ 5200. The continuous spectra have been carefully examined on more than forty different photographs of the alkali metal salts, including sulphates, nitrates, carbonates, and chlorides; also potassium cyanide, ferrocyanide, ferricyanide, and fluosilicate.

A hitherto undescribed feature in the spectra which is unquestionably due to each metal, is the occurrence of a multitude of bands in the rays of lithium, sodium, and potassium, which occupy spaces within the above-quoted wave-lengths.

The photographed spectra of potassium chloride, as emitted by different flames, were studied. In no case did the nature of the salt, the support used, or the nature of the flame, make any difference, except in lengthening or shortening the exposure which, *during comparatively short periods*, was proved to have the same effect as putting more or less of the salt into the flame.

It is deemed of importance that this should be recorded, because different metals, and also different salts of the same metal, under the same conditions show different results, and this arises principally from the difference in volatility of the salts, or the comparative ease with which they are thermo-chemically decomposed. It is also important that the salts be pure, otherwise the spectrum of one may interfere with the other, the two spectra become confused, and the bands are not visible.

Lithium Salts.—Various specimens of the sulphate, carbonate, chloride, and nitrate were used, but most of the spectra were photographed from the nitrate. Latterly the salts obtained have been so pure that the sulphate showed hardly a trace of any other metal, even sodium, and no calcium. (These salts were kindly presented to me by Mr. W. E. B. Blenkinsop, the Managing Director of the firm of May and Baker, Ltd., of Garden Wharf, Battersea, London). They show all the lines attributed to lithium by Kayser and Runge. The structure of the background is that of fine lines and very narrow bands extremely close together, extending from λ 3466 to λ 4677. But it must be observed that a feeble group of the water-vapour lines may be seen on other spectra extending to λ 3466; therefore to be sure that these may not be mistaken for lithium bands, it is better to place the margin of the latter below λ 3610 and to disregard the rays of greater refrangibility. The lithium bands, therefore, without doubt, extend from λ 3610 to λ 4677. The lithium spectrum exclusive of the lines, is a very weak one, so that an extended band of continuous rays is more often photographed than a discontinuous spectrum consisting of a multitude of fine lines and narrow bands.

Sodium Salts.—The banded spectrum of sodium has been observed on three photographs, but it is only feebly visible. A complete array of the bands was photographed from very pure rock salt, and from a specially prepared pure sodium chloride. Like the lithium bands, they are very narrow and close together; they extend from rays a little less refrangible than λ 3700 down to about λ 4800. A beautiful banded spectrum has recently been photographed from sodium carbonate in the oxyhydrogen blowpipe flame. Some feeble lines accompany the bands, and the principal lines D^1 and D^2 are enormously extended on each side so as to form a broad band. O. H. Basquin (*Astrophys. Journ.*, 1901, xiv., 1) observed a series of lines in the spectrum of the sodium arc when surrounded by an atmosphere of hydrogen; they lie between λ 5000 and 3800. "This is probably a complicated fluting of heads of bands, less clearly marked than usual, and running towards shorter wave-lengths." It is more than probable that the bands which I have observed are of the same nature as

* A Paper read before the Royal Society, January 31st, 1907. (Revised March 22nd).

those which he, by the aid of a large concave grating, resolved into lines.

(In lieu of any better hypothesis Basquin supposed that the banded spectra of several of the metals, including sodium, are due to hydrides being formed in the arc. Sodium hydride cannot exist in a state of vapour; it readily undergoes dissociation, which commences at 200°, and is complete at 422°, under ordinary barometric pressures; the bands, therefore, are not due to sodium hydride).

There is an important difference between the spectrum of sodium taken from the metal when burnt in a Bunsen flame and that obtained in the oxyhydrogen blowpipe flame, but it appears to be due solely to the lower temperature of the former. With metallic sodium, no lines but the principal yellow ones are visible; these are very broad and dense. It is extremely difficult to introduce sodium into the oxyhydrogen blowpipe flame, because it melts so readily and escapes. The sodium spectrum from salts gives not only the D^1 and D^2 lines more widely extended on either side than is the case with the metal, but also the subordinate series of lines, the band of continuous rays, and with the highest temperature of the flame, the series of bands in these rays in addition.

Potassium Salts.—The potassium bands are very easily photographed from many different salts. They are themselves wider, and also wider apart than those of lithium and sodium, and the structure of the banded spectrum varies greatly with the quantity of the substance used and with the exposure given. Many lines accompany the stronger banded spectrum.

The potassium bands, as obtained from weighed quantities of potassium chloride, frequently extend from λ 3600 to λ 4800. This effect is obtained from 0·05 grm. of the salt, but with 1 grm. or an exposure of five minutes, the bands may stretch down into the red. With an exposure of one and a-half minutes there is barely an indication of bands, and when the quantity of the chloride is reduced to 0·025 grm., there is nothing but a continuous spectrum to be seen. Potassium cyanide and ferrocyanide with the same exposure both yielded very dense spectra, but on that account the bands are not seen distinctly. They are well seen in spectra photographed from potash-alum, potassium carbonate, and potassium ferricyanide. Between the wave-lengths of two cadmium lines, 4800·8 and 4414·5, ten of these bands were counted. They are not sharp at the edges, and the spaces between successive bands decrease as they tend towards the violet. They appear, in fact, like a continuation of the subordinate series of lines, 4808·8, 4803·8, 4796·8, 4788·8, and 4759·8 (Liveing and Dewar), but they are diffuse. There is an absence of any accompanying fine lines such are seen in the lithium and sodium spectra. Spectra from sodium and potassium carbonates have recently been photographed with Wratten and Wainwright's panchromatic spectrum plates, which give the lines well defined with the continuous rays from wave-lengths 7699·3 and 7665·6 of potassium to a line 3303·1 which belongs to sodium. There is a strong band in the red, extending from λ 6911 to λ 7350, fading away rather abruptly on the less refrangible side, but with feeble continuous rays extending to λ 7665·6. The bands mentioned above are seen to be composed of two groups; the one nearer the red appears like the continuation of the subordinate series of lines with the spaces between them decreasing, and the second group more towards the violet, where the bands do not appreciably vary in width or in distance apart.

Rubidium Salts.—Sulphate and chloride of great purity yielded merely a continuous spectrum in which there are no bands, but the lines are very broad and strong.

Cæsium Salts.—The same effect is seen with the corresponding salts of cæsium.

Banded Spectra from the Alkaline Earth Salts.

The banded spectra observed with barium chloride and strontium sulphate are reproduced, but with a dispersion of only one prism on Plate 6, in "Flame Spectra at High Temperatures" (*Phil. Trans.*, 1894). In course of a study of the oxyhydrogen flame spectra of calcium, strontium, and barium compounds, made in 1902, bands were constantly observed in minerals containing barium, just as the bands of lead are constantly seen in the flame spectra of minerals containing lead, and, subsequently, the barium bands were photographed from the flame spectra of very carefully prepared compounds which were spectroscopically pure.

The bands in the continuous background of rays are different from those of the alkali metal group. In calcium and strontium the most conspicuous bands are broad and disposed somewhat irregularly, but in detail the spectra of calcium, strontium, and barium compounds show bands of two varieties, the one broad overlying narrow bands; when the quantity of material is small, only the narrow bands are seen, and when the slit is not narrow enough they appear as diffused rays or a continuous spectrum. As in the lithium, sodium, potassium group, the calcium, strontium, and barium spectra differ much in intensity, and follow in the same order as the alkali metals in this respect, which is that of the numerical values of the atomic weights of the metals, the higher the value the greater the volatility of the compound. The strontium and barium chlorides exhibit the banded spectra best, but they are well seen also in sulphates, carbonates, and oxides. The best mineral in which to study the bands of calcium is the natural sulphate, selenite. It should not be overlooked that compounds yield their own spectra, such as chlorides, under certain conditions, phosphates, and fluorides, as, for instance, ferrous phosphate and calcium fluoride. The oxides B_2O_3 and P_4O_{10} also emit their own spectra, but whereas the former shows bands the latter shows lines only. This has been made the basis of a method of separating alkali metal flame spectra from those of the alkaline earth metals (*Trans. Chem. Soc.*, 1893, lxiii., 138). Bands characteristic probably of the sulphates may be found to overlie the metal bands.

Several different compounds of barium have all been found to yield the same banded flame spectrum when a sufficient quantity of substance is introduced into the flame, and all strontium salts also yield in like circumstances the same flame spectrum. When the sulphates of the alkaline earths are submitted to the oxyhydrogen flame, they all yield the banded spectra, and in the case of calcium and strontium sulphates, also certain lines in addition, but barium sulphate frequently shows only the bands without the barium line; therefore, the lines appear more readily than the bands with calcium salts, and the bands more readily than the lines with barium compounds. In fact, barium behaves in this respect very much as lead does.

There is an important difference in the chemical nature of the three sulphates after being heated in the flame; thus, the barium sulphate is entirely reduced to sulphide, so that we arrive at the fact that the same spectrum is common to chloride, oxide, and sulphide. But the chlorides are converted by the water-vapour in such a flame into oxides, so that we have simply the oxide and sulphide to consider.

The strontium sulphate is reduced partly to oxide and partly to sulphide under precisely the same conditions, and the calcium salt is simply converted into oxides. As the oxide produced from the chloride and sulphide produced from the sulphate of barium yield exactly the same banded spectrum, it is evident that we are dealing with the spectrum of the only constituent in common, which is the metal. It is quite inconceivable that the oxide and sulphide should give identical spectra of the respective compounds because the molecular weights of the compounds are different. The same observation applies to the compounds of strontium, which yield spectra with lines and bands, but we know that strontium sulphate, after it has been removed from the flame, has by less than one-half been reduced to sulphide; it is therefore probable that in this case, as in that of barium, the spectrum is caused either by the dissociation

of the sulphide in the flame or by a chemical reduction. Calcium sulphate is not simply deoxidised in the flame, like the corresponding salts of strontium and barium, but is converted into lime, yet this compound exhibits both lines and bands.

Evidence of Thermo-chemical Reduction of Refractory Oxides in the Flame.

It has already been shown that aluminium can be reduced from its oxide in the oxyhydrogen flame, that it colours the flame, and emits the two lines λλ 3967 and 3946. It was concluded that bands which have been attributed to the oxide are in reality metal bands ("Banded Flame Spectra of Metals," p. 346, and Plate XXXI.). Bands of beryllium and lanthanum were also reduced from their oxides; the greater volatility of metallic beryllium caused the band spectrum to be photographed without the lines. (This was observed by Pollok in its reduction by the arc).

I have now arrived at the conviction, from additional evidence presently to be adduced, that calcium and strontium are also produced in the oxyhydrogen flame by thermo-chemical reduction of their oxides and sulphides.

The question of the reduction of the oxides of the dyad and triad groups is quite different from that of the oxides of the alkali metals, because compounds of the latter are not only easily volatilised, but it has been proved by Ste.-Claire Deville that in the manufacture of the alkali metals, the oxides are thermo-chemically dissociated, and then reduced by carbon entering into immediate combination with the dissociated oxygen.

Spectro-chemical Evidence from Anhydrous Flames and Dehydrated Salts.

By an anhydrous flame is meant, one in which water is not a product of combustion. Any salt which yields the spectrum or imparts the characteristic colour of the metal to such a flame, is excluded from the view of Arrhenius that vapourised salts are first hydrolysed by water-vapour in the flame, that the hydroxides thus formed undergo ionisation, and the spectra are caused by the metallic cations. Smithells, Dawson, and Wilson first applied this test to alkali salts, by heating them in the flame of burning cyanogen (*Proc. Roy. Soc.*, 1899, lxiv., 142). Lenard also has observed that sodium salts colour the flame of carbon disulphide. The authors aforesaid suggest that a chemical reduction takes place, and the metal then colours the flame. I have extended this inquiry by placing anhydrous salts in the flame of carbon monoxide. Smithells has shown that, if this gas be carefully dried, it will not inflame when issuing from a jet, but if the jet be heated the gas ignites. It has also been shown that carbon monoxide stored over water in a gas-holder will not inflame in air if the jet be small like that of a Bunsen or ordinary "bat's wing" burner, but it will burn from a tube if the orifice be wide enough, and even from a "bat's wing" burner when the pressure is small; though in these latter circumstances the flame is very small (see Hartley, "On the Temperature of certain Flames," *Trans. Chem. Soc.*, 1896, lxix., 844). In view of these facts, pure carbon monoxide was most carefully dried, first with a column of pumice saturated with oil of vitriol, and then with two large tubes of phosphoric anhydride.

The gas was conducted into a platinum tube with an internal diameter of 6 mm. and a length of 30 cm. It was found that under these conditions the gas was very difficult to inflame, but it did burn; nevertheless, to increase the temperature and render the same steady by ensuring combustion, the tube was heated red-hot by a Mecke burner placed 3 inches from its orifice.

On introducing into the flame recently ignited carbonates of lithium, sodium, and potassium, even without heating the platinum tube, beautiful spectra were observed, such as are visible in the flame of a Bunsen burner. It was very difficult to see the red line of potassium about λ 7660, but the green glow and a group of green lines about λ 5800 were observed. Experiments were tried in both the inner and outer cones, but only when the substance was heated at the tip of the inner cone could the group of green lines be seen. In this instance it is not reasonable to suppose that sufficient water could gain access to the flame to give rise to hydrolysis, and, in fact, hydrolysis could not take place.

The same experiments were repeated with the oxides, carbonates, nitrates of calcium, strontium, and barium; but although the platinum tube was heated to bright redness, there was no trace of a spectrum of either bands or lines in any case. Calcium, strontium, and barium chlorides, on the other hand, showed superb spectra of the chlorides, apparently identical with those produced by heating the same salts in a coal-gas flame saturated with hydrochloric acid. The temperature of this carbon-monoxide flame, which was from 50 to 75 mm. long, is higher than that of a Bunsen burner of the same size (*loc. cit.*), and can raise a larger mass of material to a higher temperature. (Platinum wire 1/40th mm. in thickness can be melted into a globule in any part of the flame). Here we have evidence that the metals of the alkalis behave quite differently from those of the alkaline earths; calcium, strontium, and barium chlorides are volatile without decomposition, for they fuse and remain clear liquids without showing turbidity for as long as is necessary to observe their spectra. Inasmuch as they appear to yield their own spectra, they behave like calcium fluoride when placed in the oxyhydrogen blowpipe flame, and doubtless other similar fluorides and phosphates. The most important facts ascertained so far are, first, the alkaline earth oxides are not volatile in the carbon-monoxide flame, or, if they are, they show no spectrum; second, the flame is a powerful reducing one to all oxides with a heat of formation not greater than that of zinc oxide, but the oxides in question are not reduced; thirdly, the temperature of the flame is higher than that of a Bunsen burner, and over a large area it is nearly as high as that of the oxyhydrogen flame; fourthly, the chlorides are volatile in an anhydrous flame, but the stability of the chlorides in such a flame is somewhat doubtful, as they may undergo dissociation.

The action of the cyanogen flame is very different from that of the flame of carbon monoxide, because cyanogen is a very powerful reducing agent.

When calcium oxide was introduced on a platinum-wire into the flame of cyanogen burning in air, there was no action low down in the flame, but when the substance was placed at the tip of the inner cone, there was a magnificent display of the same spectrum as that seen when calcium metal is burnt in air, and with no trace of the cyanogen bands. The effect on baryta was tested in a similar manner, by making pure barium carbonate into a stiff paste with water, and moulding it round a loop of platinum-wire. On placing this in the flame at the same point, an equally fine spectrum of barium was obtained. In both instances the spectra were identical with those photographed when the same compounds were placed in a Mecke burner, but the brilliancy and intensity of the rays were greatly increased.

Beyond all doubt these spectra are the spectra of the metals.

The deductions from these facts are, that the lines and bands seen in the oxyhydrogen flame are certainly not the spectra of the oxides, because if the difference between this and the carbon monoxide flame were simply one of temperature, the emission spectra of oxides and sulphides should be quite as easily produced in a carbon monoxide flame as in one of hydrogen. Finally, carbon monoxide was burnt with oxygen in a Deville blowpipe, and still no spectrum of calcium or strontium was seen, except when traces of chloride were present. The salts were supported on very thin slips of Donegal kyanite.

The presence of hydrogen in the flame is therefore a necessary element in some chemical reaction which leads to the reduction of the sulphides or oxides to the metallic

state. The temperature of these flames, which can melt platinum, is sufficient to effect the thermo-chemical dissociation of water-vapour, and it is probable that in this lies the cause of the spectra appearing.

Spectra of the metals observed in a carbon monoxide flame on the grandest scale are those which were photographed from the Bessemer "blow," but in this case the spectra are not due to the heating of a substance in a pure gas or even in a mixture of gases, but are the result of the internal combustion of impurities in the metal, which causes the vapours to be carried off in a stream of intensely heated carbon monoxide mixed with nitrogen and a small proportion of hydrogen, all of which gases, except the nitrogen, are burnt in the air. The average vapour pressure of water in the blast amounts to about 1 *per cent* of the air; this is reduced by the metal bath to hydrogen and carbon monoxide, and, as the temperature is an exceedingly high one, it is not surprising that a line spectrum of calcium seen in the oxyhydrogen flame has been photographed in the Bessemer flame, the flame being a mixed hydrogen and carbon monoxide one. The lines are, however, only two, namely, 4226·9 and 4581·6. Arguments from Bessemer flame observations rather lead to confusion, on account of the many other elements present in the flame, and they must therefore be rejected or treated with discrimination.

It will be observed that in the groups Li, Na, K, and Ca, Sr, Ba, the facility with which the bands are produced increases with the atomic weights, likewise the volatility of metals increases in the same order, and as, in the first group, the elements are monatomic, the relative vapour densities are half their atomic weights; accordingly we have 7/2, 23/2, 39/2 as the relative quantities of matter in the flame if they have all the same volatility, and if their oxides undergo dissociation with equal facility; but the least easily dissociated is the least volatile lithium oxide; we may therefore say that the vapour pressure of potassium will be at least six times that of lithium in any flame in which the two oxides are placed under the same conditions. As there is very little difference between the heats of formation of the groups of oxides, CaO, SrO, and BaO, the energy required for their reduction may be considered to be the same for each oxide. The respective volatilities of the oxides or of the metals is not known, neither are we acquainted with their vapour densities; accordingly we may assume them to be either monatomic or diatomic molecules; if the latter, then the relative quantities of vapour in the flame will be in the proportion of the atomic weights, or 40. 87·6, and 137·4; if they are monatomic, half these quantities, which gives three and a-half times as much vapour of barium in the flame as of calcium, under the same conditions in either case. If, however, we attempt to compare the vapour densities of the alkali metals with those of the dyad group as judged by their spectra, we are at once met with a difficulty by the reactions in the flame by which the metals are set free, being different for each group.

(To be continued).

Chemical Society.—An Extra Meeting will be held on Thursday, June 13th, at 8.30 p.m., when Professor J. B. Farmer, F.R.S., will deliver a discourse entitled "Some Borderline Problems in Botany."

Royal Institution.—A General Monthly Meeting of the Members of the Royal Institution was held on the 3rd instant, Sir James Crichton-Browne, Treasurer and Vice-President, in the Chair. Commander G. R. Bethell, late R.N., and Dr. Hans Goldsmidt were elected Members. The Chairman reported the decease of Sir Benjamin Baker, K.C.B., a Manager, and a Resolution of Condolence with the relatives was passed. The Special Thanks of the Members were returned to Mr. Oswald Lewis for his donation of 5 guineas to the fund for the Promotion of Experimental Research at Low Temperatures.

THE RAPID DETERMINATION OF NICKEL IN STEEL.*

By Dr. GEORGE T. DOUGHERTY, Chicago, Ill.

(Concluded from p. 262).

Method for Cupriferous Nickel Steel.

A large majority of pig irons and steels produced in the United States are practically free of copper. The main source of copper steels in circulation is Cornwall ores in the Lebanon, Pa., District, which yield pig irons running 0·75 to 1·25 per cent of copper. Copper, like nickel, reacts with potassium cyanide, and therefore if both copper and nickel are present in a steel, copper must be previously removed or allowed for. If we do not know beforehand the exact per cent of copper present and must separate it from nickel we will start by treating 1 grm. of steel with 20 cc. hydrochloric acid (1·10 sp. gr.) When action ceases flocks of insoluble carbide of nickel will be seen floating in the solution. Add 2½ cc. nitric acid (sp. gr. 1·20) and boil one minute to decompose nickel carbide and oxidise the iron. Proceed further, as described in the above method, for copper-free nickel steel to the point of filtering after precipitating with ammonia and diluting to 500 cc. If copper is absent or is present only in small quantity the ammoniacal filtrate will be very faintly bluish or greenish from the presence of nickel, but if 1 per cent of copper is present in the sample the ammoniacal filtrate will be pretty plainly blue. One per cent of copper makes a far stronger blue colour with ammonia than 3½ per cent of nickel does. Now take 250 cc. of the filtrate; add 25 cc. hydrochloric or just enough to acidify it, and then 14 cc. more, so that the liquid will contain 5 per cent of free hydrochloric acid, and then be sufficiently acid when sulphuretted hydrogen gas is subsequently passed into it to precipitate copper free of any nickel. An apparently trifling precipitate of copper sulphide may amount to notable figures, and therefore must be filtered off and washed with water containing some sulphuretted hydrogen. The filtrate is next boiled and oxidised if necessary with a little potassium chlorate to clear up. Add ammonia to neutralise, not over 1 cc. in excess. Cool and titrate.

Solutions Required.

Ammonium Chloride Solution.—Use 555 grms. of the salt in 2 litres of water. If there is any sediment, filter. The salt dissolves readily without any application of heat if the bottle is shaken vigorously. It is often more convenient to make it up by mixing hydrochloric acid and ammonia, as described elsewhere in this article. Of ammonium chloride solution 270 cc. is needed for each analysis, taking 1 grm. of steel.

Standard Nickel Solution.—Dissolve 2·0040 grms. of Merck's "highest purity" nickel in nitric acid and dilute to 2 litres. Each cubic centimetre equals 0·001 grm. nickel. In lieu of Merck's nickel Orford Copper Company's commercial nickel may be used, on the basis of being 99 to 99½ per cent, say 99·25 per cent.

Standard Potassium Cyanide Solution.—Use 24 grms. in 2 litres. It changes slowly and appreciably, and must be re-standardised every two or three days for particular work. For standardisation, take 50 cc. of the standard nickel solution (equals 0·050 grm. nickel) with a pipette; let it run into a No. 4 Griffin beaker; add 100 cc. water, 50 to 80 cc. hydrochloric acid; throw a bit of litmus paper; add nearly as much ammonia as you have added hydrochloric acid and then more, until the litmus paper has turned blue; add a little hydrochloric acid to acidify, and again, but very cautiously, ammonia, ½ to 1 cc. at a time, until the colour of the solution has become bluish or the litmus paper has turned blue, not over 1 cc. in excess. Throw out the litmus paper after rinsing it slightly. Cool.

* From the *Iron Age*, April 25, 1907.

Add 5 cc. of silver nitrate solution and 5 cc. of potassium iodide solution, whereupon a white opacity or cloudiness will develop in the liquid. Run the potassium cyanide in from a burette and toward the end move cautiously, one drop at a time, with good stirring until the very last drop suddenly clears up the whole liquid. Deduct 0·2 cc. from the burette reading for a blank correction, and by the remainder divide 0·050 grm. nickel. One cubic centimetre of the freshly made potassium cyanide solution is equivalent to about 0·002500 grm. nickel.

MERCHANT VENTURERS' TECHNICAL COLLEGE, BRISTOL.

The plans for the restoration of the main building of this College have now been approved by the Society of Merchant Venturers; they involve very considerable changes in the arrangements of the original building.

In the basement the engineering workshop and forge will still be located; as also the electrical engineering laboratory and the hydraulic laboratory, both of which will, however, be much larger. A large special shed for motor car engineering will be provided, and it is hoped that the provision of a special department of this kind will not only be useful to young men in the city and West of England, who desire to enter this promising branch of engineering, but that it may also tend to a great development of the motor car industry in the city itself. A portion of the space at the back of the College will be covered over, and in it will be placed the experimental engine, dynamos, and central electric light and power station, now situated in the Rosemary Street branch building of the College, as well as the testing machines of various kinds. On this floor also will be found the rooms of the Professors of Electrical Engineering and Motor Car Engineering, the boiler house, heating chamber, battery house, and the head porter's lodge.

On the ground floor the Great Hall will be retained in its original position, and here also will be the rooms for the Governors, Principal, Registrar, Clerks, and Professor of Mathematics, together with three ordinary class-rooms, a lecturer's common room, a large common room for male students, and the head porter's house.

On the first floor will be found the gallery of the Great Hall, a large mechanical laboratory, engineering lecture room, drawing office, refectory, and a woman's common room, as well as a room for the Professor of Mechanical Engingeering, cloak-rooms, &c.

The second floor will include the lesser hall, physical laboratory, optical laboratory, photographic laboratory, physical lecture theatre, two science lecture rooms, two ordinary class-rooms, library, research laboratory, &c., while on the new third floor provision is made for a gymnasium with dressing room, lavatories, &c., attached, and for the chemical department, which will include a chemical lecture theatre, preparation room, elementary chemical laboratory, advanced chemical laboratory, balance room, combustion room, Professor's room, and stores. The fume closets will be built outside the main laboratories, so will also the store for dangerous chemicals.

It is confidently expected that the whole of the work of restoring and refitting the building will be completed in time for the students to return to the main building in September, 1908. From the description of the provision to be made, it will be seen that the Governors are concentrating the work of their College so as to provide a much more extensive equipment for those departments which train civil, mechanical, electrical, mining, and motor car engineers, and which prepare for the B.Sc. degrees of the University of London in Science and Engineering. With this end in view they will discontinue certain portions of the work formerly undertaken by the College.

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

Part II.—Analysis of the Silver, Copper, and Tin Groups.

By Arthur A. Noyes and William C. Bray.

(Continued from p. 260).

Test Analyses.

Numerous analyses were made to test the efficiency of the process above described. Nearly all of those which were made after the procedure assumed final form are reproduced in the tables below. In these tables the numbers in each vertical column show the weights in milligrms. of the various elements which the solution submitted to analysis contained. The results of the tests for each element are shown by the letters following these numbers. That the result was satisfactory is indicated by the letter S; that is, when the element was present, that the test for it, however small, was unmistakable, and therefore conclusive, and when the element was absent that a good blank test was obtained. When the test was very small, especially in comparison to the quantity of the element present, though still unmistakable, this is sometimes indicated by the symbol S—. When in the presence of the element the test failed, or in its absence a result was obtained that might be thought to indicate its presence, the letter F is used. When the result was doubtful or inconclusive, owing to the appearance or small size of the precipitate, this is indicated by the letter D. When the test was not tried, if the element was present, a dash is used in place of a letter; or, if the element was not present, dots are inserted.

Silver Group.

All these analyses (Nos. 1—9) were begun at P. 11 and carried through P. 15.

T.A. No.	1	2	3	4
Pb	500 S	500	..	..
Ag	0 S	1 S	500 S	500 S
Hg	0 S	1 S	0 S	1 S

T.A. No.	5, 6	7	8	9
Pb	..	..	..	..
Ag	0 S	1 F	1 S—	2 S
Hg	500 S	500 S	500 S	500 S

Copper Group.

Analyses Nos. 10—20 were begun at P. 21 and were carried through P. 23—30, P. 22 being omitted. In addition, tin was tested for by P. 25, 41, 42, 45, and 47.

T.A. No.	10	11	12	13
Hg . ..	500 S	500 S	500 S	500 S
Sn (ous) .	0 S	2 F	4 S	2 S—, F (*a*)
Pb	0 S	1 S—	1 F	2 S
Bi	0 S	1 S	1 S	0 S
Cu	0 S	1 S	1 S	0 S
Cd	0 S	1 S	1 S	0 D (*b*)

T.A. No.	14	15	16	17
Hg . ..	1 S—	0 S	0 S	1 S
Sn (ous) .	2 S—, F (*a*)	0 S	0 S	2 S
Pb . ..	1 S	0 S	0 S	1 S
Bi	500 S	500 S	0 S	1 S
Cu . ..	1 S	0 S	500 S	500 S
Cd . ..	1 S	0 S	0 D (*b*)	1 S

T.A. No.	18	19	20
Hg	0 S	1 S	2 S
Sn (ous)	0 S	2 S	0 S
Pb	0 S	1 F	1 S
Bi	0 S	1 S	1 S
Cu	0 S	1 S	1 S
Cd	500 S	500 S	500 S

* From the *Technology Quarterly*, xix., No. 3, September, 1906.

Analyses Nos. 21—28 were begun at P. 21, the H_2S precipitate was digested once with 10 cc. ammonium polysulphide (P. 22), and the residue analysed by P. 23—30.

T.A. No.	21	22	23	24
Hg (ic)	2 S	1 D	..	..
Cu	..	..	2 S— (*c*)	5 S
Bi	..	..	..	..
Sn (ous)	..	..	300 S	300
Sb (ous)	300 S	300 S	..	..

Ta No.	25	26	27	28
Hg (ic)	..	..	..	..
Cu	3 S	2 S	2 S (*c*)	3 S
Bi	..	500 S	..	..
Sn (ous)	300	..	50 S	..
Sb (ous)	..	..	..	200 S

Analyses Nos. 29 and 30 were made in the same way, except that 25 cc. ammonium monosulphide was used.

T.A. No.	29	20
Hg (ic)	1 S	1 S
Cu	1 S (*e*)	1 F
Sb (ic)	300 —	..
As	..	250 —
Sn (ic)	..	250 —

Tin Group.

In analyses Nos. 31—56 the substances were dissolved directly in ammonium polysulphide and the solution treated by P. 41—47.

T.A. No.	31	32, 33	34, 35, 36	37, 38	39, 40	41, 42, 43
As	0 S	2 S	1 S	500 S	..	..
Sb	500 S	500 S	500 S	0 S	0 S	1 S
Sn	..	..	..	0 S	500 S	500 S

T.A. No.	44, 45	46	47	48	49	50
As	..	..	..	0 S	1 S	..
Sb	500 S	500 S	500 S	0 S	1 S	1 S
Sn	0 S	1 S— (*f*)	1 S	500 S	500 S	1 S

T.A. No.	51	52	53, 54	55	56
As	2 S	1 S	500 S	500 S	500 S
Sb	2 S	200 S	1 S	1 S	0 S
Sn	2 S	500 S	1 S	1 S—, F (*a*)	1 S

In experiments Nos. 57—90, in which a large quantity of an element of the copper group was present with the tin group, the analysis was begun at P. 21, the H_2S precipitate was treated once with 10 cc. ammonium polysulphide, and the solution analysed by P. 41—47. The copper group residue was not treated by P. 23—25 to recover tin.

T.A. No.	57	58	59	60	61	62
Bi	500 —	500 —	500 —	500 —	500 —	500 —
As	0 S (*g*)	1 F	2 S	1 S	..	..
Sb (ous)	0 S	1 S	2 S	0 S	..	..
Sn (ous)	0 S	1 F	2 S	0 S	2 S	1 S (*h*)

T.A. No.	63	64	65	66	67	68
Hg	500	500 —	500 —	500 —	500 —	500 —
As	0 S (*g*)	1 S	2 S	0 —	..	..
Sb (ous)	0 S	1 S	2 S	0 S	..	..
Sn (ic)	0 S	1 F	2 F	5 F	5 F	10 S (*i*)

T.A. No.	69	70	71	72
Cu	500 —	500 —	500 —	500 —
As	0 S (*g*)	1 S	2 S	0 S
Sb (ous)	0 S	1 S	2 S	0 S
Sn (ous)	0 S	1 F	2 F	2 F

T.A. No.	73	74	75
Cu	500 —	500 —	500 —
As	..	..	..
Sb (ous)	..	..	..
Sn (ous)	4 S—, F (*a*)	5 S (*i*)	3 S—, F (*a*) (stannic)

T.A. No.	76	77	78	79, 80	81
Cd	500 —	500 —	500 —	500 —	500 —
As	0 S	2 S	1 S	1 S	0 S
Sb (ous)	0 S	2 S	1 S	1 S	0 S
Sn (ous)	0 S	2 F	0 S	2 F	10 F
Sn (ic)	0 S	..	..	..	..

T.A. No.	82	83	84	85
Cd	500 —	500 —	500 —	500 —
As	..	..	..	..
Sb (ous)	..	..	..	..
Sn (ous)	10 S—, F (*a*)	15 S (*h*)	15 S—, F (*a*)	20 S (*i*)
Sn (ic)	..	..	..	..

T.A. No.	86	87, 88	89	90
Cd	500 —	500 —	500 —	500 —
As	..	..	..	..
Sb (ous)	..	..	..	..
Sn (ous)	25 S—, F (*a*)	25 S	..	..
Sn (ic)	..	..	3 F	5 S (*i*)

Analyses Nos. 91—97 were made by Mr. A. L. Smith in the same way as the preceding ones, except that 25 cc. ammonium monosulphide, instead of 10 cc. polysulphide, were used in digesting the H_2S precipitate.

T.A. No.	91	92	93	94
Hg (ic)	..	..	..	..
Bi	500 —	500 —	..	..
Cd	..	..	..	500 —
Cu	..	..	500 —	..
As (ic)	..	..	..	..
Sb (ic)	2 S	4 S	2 S	2 S
Sn (ic)	5 F (*m*)	10 F (*m*)	5 S	5 S

T.A. No.	95	96	97
Hg (ic)	..	..	500 —
Bi	500 —	..	..
Cd	..	250 —	..
Cu	..	250 —	..
As (ic)	..	..	1 S
Sb (ic)	1 S	1 S	1 S
Sn (ic)	5 F (*m*)	5 F (*m*)	5 F (*m*, *n*)

In analyses Nos. 98—100, also made by Mr. A. L. Smith, the solution in ammonium monosulphide and the residue were treated separately in order to detect tin. It was not detected in any case in the analysis of the solution. The results shown in the table were obtained in the analysis of the residue.

T.A. No.	98	99	100
Hg (ic)	250 —	250 —	..
Bi	250 —	250 —	..
Cd	..	..	250 —
Cu	..	..	250 —
Sn (ic)	2 F	5 S	3 S—, F (*a*)

Mixtures containing the Rarer Elements.

Analyses Nos. 101—105 were made, starting at P. 41, with an ammonium polysulphide solution, and following P. 42, 43, and *P. 43*a*—43*e*.

T.A. No.	101	102	103	104	105
As	..	..	300 S	200 S	200 S
Sb	..	..	200 —	..	..
Sn	..	..	200 —	200 —	200 —
Se	0 S	1 S	1 S	1 S	0·5 S
Te	0 S	1 S	1 —	2 S	1 S
Mo	100 S	50 S	1 S	0 S	0·5 S

Analyses Nos. 106—108 were begun at P. 21, the H_2S precipitate was extracted with ammonium polysulphide (P. 22), the solution was analysed by P. 41—43 and *P. 43*a*—43*e*, and the residue treated by P. 23, 24, and *P. 24*a*.

	T.A. No.	106	107	108
Cu	.. .. ..	300 —	200 —	100 —
Hg	.. .. ..	0 S	0 S	0 S
Pt	.. .. ..	5 S (*l*)	3 S (*k*)	2 S (*k*)
Au	.. .. ..	5 S (*k*)	3 S (*k*)	1 S (*l*)
Te	.. .. ..	..	..	10 S

Analyses Nos. 109—111 were made by Mr. A. L. Smith, beginning with P. 21 and following through the whole process as described in P. 21—47. Ammonium monosulphide was used in separating the copper and tin groups.

T.A. No.	109	110	111	112 (*s*)	113
Hg (ic)	1 D (*o*)	1 —	1 F (*o*)	..	2 D (*o*)
Pb ..	1 F	1 S	1 S—	..	1 S
Bi ..	0 S	1 S (*t*)	1 S (*t*)	..	1 S
Cd ..	1 D	1	1 F (*q*)	1 S	2 S
Cu ..	1 S	1 S	1 S	..	1 S
As (ic).	1 F	1 S	1 S	..	1 S
Sb (ic).	0 S	1 S	1 S—	1 S	1 S
Sn (ic).	2 S	1 S—, F (*a*)	1 S—, F (*a*)	..	2 S
Pt ..	1 S (*p*)	1 S (*u*)	1 S	..	1 S (*p*)
Au ..	1 S (*p*)	1 S (*u*)	1 S (*p*)	..	1 S (*p*)
Se ..	1 F	1 F (*x*)	1 S—	1 S	2 F (*x*)
Te ..	1 F	1 F	1 S— (*r*)	1 S	2 F (*y*)
Mo ..	1 D	1 D	1 S— (*r*)	1 S	2 S

The test analyses of the silver group (Nos. 1—9) show that 1 mgrm. of mercurous mercury is detected in the presence of 500 mgrms. of either lead or silver; and that 1 mgrm. of silver is detected without difficulty in the presence of 500 mgrms. of lead, but that in the presence of 500 mgrms. of mercury 1 mgrm. of silver lies at about the limit of detectability.

The test analyses of the copper group (Nos. 10—20) show—at any rate when the ammonium sulphide treatment is omitted—that even 1 mgrm. of mercury, bismuth, copper, or cadmium is detected in the presence of 500 mgrms. of any other one of these elements; that with lead in presence of 500 mgrms. of any one of these elements 1 mgrm. is near the limit, probably owing to the difficulty of securing complete precipitation with H_2S; and that with stannous tin the limit of detectability is at 2 mgrms. The blank tests were satisfactory in all cases, except that a very small dark precipitate was sometimes obtained in the cadmium test with H_2S. Even when the H_2S precipitate was treated with ammonium polysulphide (T.A. Nos. 21—28), which dissolves some copper and mercury, these elements were detected in all cases where 2 mgrms. were present; and when monosulphide was used (as in T.A. Nos. 29 and 30) 1 mgrm. of mercury was twice detected, while with copper it was found in one analysis and lost in the other.

The test analyses of the tin group in which the copper group was not present, which were begun with an ammonium polysulphide solution of the elements (Nos. 31—56), show that 1 mgrm. of arsenic, antimony, or tin is invariably detected, even in the presence of 500 mgrms. of any other one of these elements.

The test analyses in which the elements of the tin group were associated with 500 mgrms. of an element of the copper group, and in which the H_2S precipitate was treated with ammonium polysulphide (Nos. 57—90), show that 1 mgrm. of arsenic or antimony is almost always detected; but that a much larger quantity of tin in some combinations is not detected if only the ammonium sulphide solution is analysed for it. Thus, while in the presence of bismuth 1 to 2 mgrms. of stannous tin were found, yet in the presence of copper 4 to 5 mgrms., and in that of cadmium 10 to 15 mgrms. of it were lost; and 3 to 5 mgrms. of stannic tin were lost in the presence of mercury or cadmium.

In the analyses in which ammonium monosulphide was used (Nos. 91—97), the detection of antimony in the higher state of oxidation and of arsenic is nearly as satisfactory, 1 or 2 mgrms. having been always found; but a larger quantity of stannic tin remains with the copper group than when the polysulphide is used, 5 mgrms. being retained even by bismuth.

These results clearly show the necessity of testing for tin in the analysis of the copper as well as of the tin group, and T.A. Nos. 98—100 show that it can be detected in the copper group analyses when 3 mgrms. are present.

In the test analyses with mixtures containing the rarer elements (Nos. 101—113) 1 mgrm. of platinum or gold was always detected; and the same was true of 1 mgrm. of selenium, tellurium, and molybdenum in the analyses that started at the beginning of the tin group, but not in those where elements of the copper group were present and the analysis was begun with the H_2S precipitation.

Notes to the Tables.

(*a*) The confirmatory test with $HgCl_2$ failed, but a distinct precipitate of SnS_2 was obtained.

(*b*) A very small dark precipitate was obtained.

(*c*) No blue colour was produced with NH_4OH, but a slight pink precipitate with $K_4Fe(CN)_6$ was visible on the filter.

(*d*) A good blue colour was obtained with NH_4OH, showing that a small quantity of copper is not dissolved out of a large copper group precipitate by the polysulphide.

(*e*) No blue colour could be seen, but a very distinct pink precipitate formed with $K_4Fe(CN)_6$.

(*f*) In this analysis the confirmatory tin test failed, but this was doubtless due to the fact that the SnS_2 precipitate was filtered off and dissolved in HCl, instead of evaporating the mixture as usual.

(*g*) The HCl precipitate from the polysulphide solution was very light coloured, or, if not, when it was extracted with NH_4OH the solution gave no precipitate with HCl, so the analysis was not carried further.

(*h*) A fair SnS_2 precipitate was produced, but owing to an accident the confirmatory test was not tried.

(*i*) The SnS_2 precipitate produced in P. 47 was estimated to contain only 1—3 mgrms. Sn.

(*k*) In these analyses the moist H_2S precipitate was left on the filter for several hours before treating with ammonium polysulphide.

(*l*) Satisfactory tests were obtained for gold and for platinum both in the copper and tin groups; and the final precipitates were not far from equal in size.

(*m*) No precipitate of SnS_2 was produced in p. 47.

(*n*) The residue undissolved by ammonium sulphide was treated by P. 23, 24, 25, 41, and 42, and the HCl solution so obtained reduced directly with Zn, the residue dissolved, and $HgCl_2$ added; but no test for tin was obtained.

(*o*) A black precipitate was produced in the test with $SnCl_2$, probably due to the presence of gold. It was treated with hot HNO_3 (1·20), and it did not dissolve, showing it was not wholly mercury; the solution, after evaporation with HCl, was tested with $SnCl_2$, but only an inconclusive turbidity was obtained.

(*p*) Tests for these elements were obtained in the analyses of both the copper and tin groups.

(*q*) All or nearly all the cadmium failed to be precipitated by H_2S from the 100 cc. of solution containing 4 cc. HCl (1·12), even though the gas was passed in for ten minutes, for it was recovered from the filtrate by adding 50 cc. more water and passing in H_2S for ten minutes, and then confirmed by P. 23, 27, and 30.

(*r*) Nearly all the tellurium and molybdenum failed to be precipitated by H_2S, for they were recovered from the filtrate by adding NH_4OH and NH_4SH and acidifying, and were detected by treating the precipitate by P. 43, *43*a*, *43*c*, *43*d*, and *43*e*.

(*s*) In T.A. No. 112 the last part of P. 43 and *P. 43*b* were omitted.

(*t*) No distinct turbidity was visible, but upon filtering and treating with sodium stannite the filter was much darkened.

(*u*) Tests for these elements were obtained only in the analysis of the tin group.

(*x*) A red precipitate separated in the lead test upon evaporating with H_2SO_4, which was probably selenium, and indicated that it had not been dissolved out by $(NH_4)_2S$.

(*y*) In testing for arsenic with $MgCl_2$ a flocculent precipitate accompanied the crystalline one of $MgNH_4AsO_4$, and on dissolving this in HCl and adding H_2S a black precipitate resulted. This was dissolved in HCl and $KClO_3$ and treated by *P. 24*a*; a black precipitate resulted, showing that tellurium was precipitated with the arsenic.

(To be continued).

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Ordinary Meeting, May 16th, 1907.

Prof. R. MELDOLA, F.R.S., Past President, in the Chair.

MR. E. GARDNER was formally admitted a Fellow of the Society.

It was announced that the following Address would be presented to the Société Chimique de France on the occasion of the celebration of its Jubilee.

Address from the Chemical Society to the Société Chimique de France.

The ties of sympathy connecting the Chemical Society of France and the Chemical Society resemble the bonds uniting members of the same family rather than those associating friends drawn together by mere community of interests.

On the occasion of our Jubilee celebration in 1891 your representative, M. Gautier, then President of the Société Chimique de Paris, reminded us that, prior to your foundation in 1857, M. Wurtz had paid a special visit to London in order to study the organisation of our Society, which had then been in existence for sixteen years, and further remarked "La Société Chimique de Londres été le modèle et la grande sœur de la Société Chimique de Paris."

It is now the privilege of the elder sister to send through her appointed delegates the congratulations of all English chemists to the Société Chimique de France on completing fifty years of active work in widening the boundaries of a science which has conferred such inestimable benefits on humanity.

How magnificent have been the contributions to knowledge made by your Society during those five decades is witnessed by your *Bulletin*, which in itself represents a historical survey of modern chemistry.

The satisfaction with which our Society embraces this opportunity of taking part in your *réunion* is not untinged by sadness, for we can no longer hope to meet amongst you two of the most illustrious of our *confrères*, whose loss your country, and, indeed, the whole world, have so recently had to deplore. This loss is felt all the more deeply by us since one of them was the doyen of our Honorary and Foreign Fellows.

In the genius of Marcellin Berthelot, the gifted founder of chemical synthesis and of thermo-chemistry, were united the savant and the statesman, a combination of qualities which must be rare in any age; whilst in Henri Moissan we mourn a colleague, the products of whose industry have been well described as taking a place amongst the greatest achievements in inorganic chemistry.

(Signed) WILLIAM RAMSAY, President.
ALEXANDER SCOTT, Treasurer.
M. O. FORSTER, | Honorary
ARTHUR W. CROSSLEY, | Secretaries.
HORACE T. BROWN, Foreign Secretary.

Certificates were ready for the first time in favour of Messrs. William Arthur Colebourne, 34, Camp Street, Broughton, Manchester; Robert Cornthwaite, Agricultural Laboratory, Halifax; Charles William Lamb Jensen, Oakhill, nr. Bath; Charles Horne Warner, 24, Gordon Street, Gordon Square, W.C.

A certificate has been authorised by the Council under By-law I. (Par. 3) in favour of Ruchi Ram Sahni, M.A., Government College, Lahore, India.

Of the following papers, those marked * were read:—

*100. "*The Relation between the Crystalline Form and the Chemical Constitution of Simple Inorganic Substances.*" By WILLIAM BARLOW and WILLIAM JACKSON POPE.

The authors pointed out that only two simple homogeneous close-packed assemblages of equal spheres exist; one of these possesses holohedral cubic symmetry, and the other holohedral hexagonal symmetry with the axial ratio, $a:c = 1:0{\cdot}8165$. They showed that close-packed homogeneous assemblages made up of two or more kinds of spheres of nearly the same size must approximate in marshalling to one or other of the above types of assemblage or some homogeneous combination of these. All the known crystalline forms exhibited by the elements can be interpreted in the light of the above geometrical principles; the latter also explain how binary compounds composed of two elements of the same valency, such as the alkali halogen compounds, crystallise in the cubic system, and how silver iodide, which crystallises in the hexagonal system, exhibits the axial ratio, $a:c = 1:0{\cdot}8196$.

An examination of the isomorphous series of tri-halogen compounds, to which the compounds CsI_3 and RbI_3 belong, shows that the axial ratios of these orthorhombic substances are also in accordance with the geometrical principles stated above.

Descriptions were given of the homogeneous assemblages corresponding to the above substances and to the ammonium salts isomorphously related to certain of them. The crystalline forms of certain of the chlorates, carbonates, and nitrates were also discussed.

DISCUSSION.

Dr. DIVERS pointed out that, for the purposes of the authors, it was surely unnecessary, and, as introducing complexity, undesirable to do more than equalise the axial ratios of similar crystals by applying the law of the rationality of the axes. When the authors went on to multiply the equalised ratios by the factor, $\sqrt[3]{W/ac}$, and entitled the results "equivalence parameters," they served no useful end, since no further "equivalence" could be conferred upon ratios (or anything else, except their more complex expression) by multiplying them by this or any other factor.

He feared that the authors were risking failure to convince many chemists of the sufficiency of the assumption of their "valency volumes" to correlate chemical with crystalline structure, by demanding for the purpose of appropriate close packing that considerable deviations from simply proportioned volumes must be allowed them; for example, that volumes of a given valency are not quite equal, even under similar conditions, when they are of different chemical elements; and that, under different conditions, these volumes may vary considerably, even when of the same element; and that, also for close packing along with perservation of mechanico-chemical structure, the valencies must be, sometimes, exceptionally chosen; that, for

example, the alkali metals are to be univalent in their trihalides; sulphur bivalent in sulphates; nitrogen, tervalent in nitrates, and oxygen in hydroxyl compounds, sometimes of no valency.

What seemed to him to be, also, a serious objection to the packing of atoms to represent chemical constitution was that juxtaposition of atoms expressed chemical union in some cases and not in others. He also doubted whether with close packing and pressing out all interspaces the appropriate distances between the centres of the spheres, shown undeformed in the models and diagrams, would be sufficiently preserved. But, without the experience of the authors, that was too difficult a point for others to deal with adequately.

Dr. Tutton said he was glad that Prof. Pope in his exposition of the authors' paper had removed the doubt which had been created by their first paper as to the light in which they regarded the use of topic axial ratios. It was now made clear that their equivalence parameters were intended to supplement, for unrelated or only morphotropically related substances, the teaching of topic axial ratios with respect to the strictly related members of isomorphous series, and that the value of the topic axial ratios for expressing the structural relationships of the members of such series was undoubted by them. He pointed out that these ratios depended solely on constants determinable with the highest experimental accuracy, namely, the crystallographic axial ratios, the molecular weight, and the specific gravity, and that whilst the molecular volume represented the total relative change of volume on passing from one member to another, the topic axial ratios gave the actual changes in the separation of the structural units, the chemical molecules, in the three directions of space. The equivalence parameters of the authors suffered from an apparent want of such precision, essentially so from the different nature of the problem, and Dr. Divers had seized on this apparent weak point. He (Dr. Tutton) felt sure, however, having now had time to consider the previous paper of the authors and having seen the present one by their courtesy, that they would be able fully to justify their position, and that they were on the right track. He believed that the topic axial ratios and the equivalence parameters would together afford a complete account of the relationship between crystalline structure and chemical constitution, and it was pleasant to think that the papers introducing both had been communicated to this Society.

*101. "*Experimental Investigation into the Process of Dyeing.*" By Julius Hübner.

The author has examined quantitatively the absorption of basic, acid, and direct dyeing colouring matters by cotton, wool, silk, and other fibrous materials at different temperatures, with and without the addition of other substances to the dye-bath.

Parallel series of measurements were made on the absorption of the several classes of colouring matters by charcoal, graphite, China clay, and lampblack, and the following conclusions were established from the comparison.

Fibres of animal origin behave towards colouring matters in the main like charcoal, whilst cotton behaves similarly to graphite.

Thus, both cotton or graphite are practically unaffected by acid dye-stuffs, either hot or cold, whilst wool or charcoal absorb the colouring matter freely.

The parallel behaviour of cotton and graphite, and of wool and charcoal is also illustrated by the effect of acids, sodium sulphate, &c., added to the dye-bath in the case of both acid and direct dyeing colouring matters. Similar analogies of behaviour are observed in the absorption of basic colours by the materials mentioned.

The relative absorptions were determined at different temperatures.

Discussion.

Dr. Divers pointed out the importance of this work as showing that dyeing was not of a chemical, but of a physical, nature. The fact that absorption by charcoal was of the same order of things as absorption of colours by fibres was of much interest.

Mr. Grant Hooper said that in the brief *résumé* of the paper which the author had given the conclusions had not been stated, and he asked whether the increased amount of colouring matter taken up by disintegrated cotton as compared with the unbroken fibre was not explained by the fact that the colour more easily gained access to the interior of the fibre when the latter was torn. He suggested that the imbricated structure of wool probably facilitated the access of dye substance to the interior of tha fibre, and so accounted in a similar manner for the comparative readiness with which wool also took up colouring matter.

He further asked whether, in view of such apparent action and of the results obtained in the experiments with fibrous material on the one hand, and charcoal and inorganic substances on the other, the conclusion was drawn that the dye was retained by a process of adsorption.

Dr. Feilmann remarked that Suida had also published extensive accounts of experiments on the dyeing of mineral substances, &c., some two years or more ago, and that Suida's results seem to show that a kind of double decomposition occurred, so that the process was of a more or less chemical character, whereas Mr. Hübner's experiments, on the other hand, tended rather to show that the process was mainly physical, depending on absorption.

102. "*Esterification Constants of Substituted Acrylic Acids.*" (Part II.). By John Joseph Sudborough and Ebenezer Rees Thomas.

As an extension of the work already published (*Trans.*, 1905, lxxxvii., 1840), the authors have determined the esterification constants of a number of unsaturated acids with methyl alcohol at 15°. The acids experimented with were cinnamic, phenyl*iso*crotonic, β-ethylacrylic, ethylidenepropionic, and allylacetic. The results indicate in a decisive manner the retarding effect which a double bond in the αβ-position has on the velocity of esterification. The constants for phenyl*iso*crotonic and cinnamic acid are in the ratio 74 : 1, and of the β-ethylacrylic, ethylidenepropionic, and allylacetic acids in the ratio 1 : 50 : 26·7.

103. "*The Addition of Bromine to the α- and β-Chloro- and Bromo-cinnamic Acids and their Methyl Esters.*" By John Joseph Sudborough and Gwilym Williams.

The products obtained by the addition of bromine to the α- and β-bromo- and chloro-cinnamic acids and their methyl esters have been examined in order to determine whether in each case the α- or β-compound and the stereoisomeric *allo*-compound yield the same dibromide.

The addition of bromine to the α-compounds does not take place readily in the dark. In daylight both α-bromo-acids yield the same *αaβ-tribromo-β-phenylpropionic acid*, m. p. 151—152°. The corresponding *methyl ester* melts at 47—48°. The two β-bromo-acids combine with bromine, both in the dark and in light, yielding the same *αββ-tribromo-β-phenylpropionic acid*, m. p. 146—147°. The corresponding *methyl ester* melts at 42—43° (decomp.). The α-chloro-acids do not combine with bromine in the dark, and in daylight each yields a mixture of two dibromides, which, so far, have not been separated.

The two β-chloro-acids combine more readily with bromine, yielding the same *β-chloro-αβ-dibromo-β-phenylpropionic acid*, m. p. 143—144° (decomp.).

104. "*The Addition of Bromine to Unsaturated Compounds.*" (Part I.) By John Joseph Sudborough and John Thomas.

The work, of which a preliminary note has already appeared (*Proc.*, 1906, xxii., 318), has been continued. The rate of addition of bromine to various olefine acids has been determined at 15° in carbon tetrachloride solution. The accelerative effect of sunlight has been confirmed. Of the following acids examined, cinnamic, crotonic, phenyl*iso*crotonic, undecylenic, oleic, elaidic, erucic, brassidic, β-ethylacrylic, ethylidenepropionic, and allylacetic acids, all those containing the double linking in the

$\alpha\beta$-position unite with bromine but slowly in the dark, whereas all the other acids absorb bromine with great readiness under the same conditions, the reaction being practically complete in a few minutes.

The characteristic behaviour of the $\alpha\beta$-unsaturated acids may be used as the basis of a method for determining whether a double linking is in the $\alpha\beta$-position with respect to the carboxylic group or not.

105. "*Separation of Cadmium from Zinc as Sulphide in the presence of Trichloroacetic Acid.*" By JOHN JACOB FOX.

A convenient method of separating cadmium from zinc as sulphide is furnished by the use of trichloroacetic acid. The quantity of trichloroacetic acid required is at least 10 grms. per 100 cc. of solution, but much greater concentrations can be used without affecting the precipitation of cadmium as sulphide. Even when the amount of the cadmium is small (5 mgrms. per 100 cc.), concentrations of trichloroacetic acid as great as 30 grms. of acid per 100 cc. do not prevent the whole of the cadmium being precipitated.

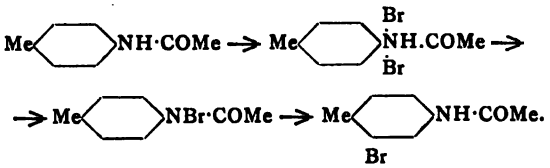
In this respect, trichloroacetic acid differs from both hydrochloric and sulphuric acids.

For the complete separation of cadmium and zinc, two precipitations are desirable; this is unnecessary, however, when the proportions of cadmium and zinc are about equal or when the cadmium is present in excess. If the presence of trichloroacetic acid is objectionable in the subsequent treatment of the solutions, a first partial separation of zinc and cadmium may be effected by the use of 1 grm. of hydrogen chloride per 100 cc. of solution.

106. "*The Mechanism of Bromination of Acylamino-compounds.*" (Preliminary Notice). By JULIUS BEREND COHEN and WILLIAM ERNEST CROSS.

In the ordinary process of brominating acylamino-compounds in acetic acid solution, the crystalline product which is first formed yields, on pouring it into water, the nuclear brominated compound. This intermediate compound has been isolated in the case of aceto-*p*-toluidide, and crystallises in brilliant yellow needles containing two atoms of bromine. It was very unstable in the dry state, slowly losing bromine, and changing into the original compound. The same result is more rapidly effected by shaking the ethereal solution with mercury or dry potassium carbonate. The ether then contains the unchanged aceto-*p*-toluidide. If, on the other hand, the bromine compound is poured into water or shaken with pyridine, &c., hydrogen bromide is at once eliminated, and a quantitative yield of 2-bromoaceto-*p*-toluidide is obtained.

The following provisional explanation is offered. An additive compound with one molecule of bromine is first formed, which in contact with water loses hydrogen bromide, and gives the nitrogen bromide compound. The latter rapidly isomerises to the nuclear substituted product:



This view would conform to that of Chattaway and Orton (*Ber.*, 1899, xxxii., 3576), in which the formation of the nitrogen bromide compound is found to precede the isomeric change from side-chain to nucleus. Up to the present, however, the authors have failed to obtain evidence of the presence of the nitrogen bromide compound.

107. "*Mixed Semi-ortho-oxalic Compounds.*" By GEORGE DRUCE LANDER.

The amide chlorides of methyl and ethyl oxanilates are stable below 100°. On decomposition by heat they pass by loss of hydrogen chloride into the imide chlorides, which are further resolved into alkyl chloride, carbon monoxide, and phenylcyanate, thus:—

$$CO_2R\cdot CCl_2\cdot NHPh \rightarrow CO_2R\cdot CCl{:}NPh + HCl \rightarrow \rightarrow O{:}C{:}NPh + RCl + CO.$$

With sodium alkyloxides the amide chlorides yield *triethyl anilido-semi-ortho-oxalate*, $CO_2Et\cdot C(OEt)_2\cdot NHPh$, m. p. 69—70·5°, b. p. 172—174°/12 mm., and *trimethyl anilido-semi-ortho-oxalate*, similarly constituted, and having m. p. 80—82°. b. p. 182°/20 mm.

When heated under atmospheric pressure these compounds yield *ethyl isodiphenyloxaluric ethyl ester*, $PhN{:}C(OEt)\cdot NPh\cdot CO\cdot CO_2Et$, m. p. 101—104°, and the corresponding *methyl* iso-*ester*, m. p. 131—133° respectively. Both *iso*-esters on hydrolysis with hydrogen chloride give diphenylparabanic acid.

(To be continued).

NOTICES OF BOOKS.

Commercial Organic Analysis. By ALFRED H. ALLEN, F.I.C., F.C.S. Third Edition. Vol. II., Part III. London: J. and A. Churchill. 1907.

OWING to the death in 1904 of the author of this treatise the revision of Volume II. has been completed by Mr. A. R. Tankard, F.C.S., to whose efficient hands the task was entrusted at the special request of the author. One portion of the book was prepared by Dr. Henry Leffmann, who revised and added to Volume I. and the other parts of Volume II. This volume treats of the acid derivatives of phenols, aromatic acids, resins, and essential oils, and the properties, use, and examination for adulterants of every substance of commercial or scientific interest, which is included in one or other of the above classes, are minutely described. Certain parts of the book have been fundamentally altered in accordance with the facts that have been brought to light by recent research, and every page has been carefully revised; no analytical chemist should consider his library complete till he has obtained a copy of the latest edition of this treatise.

A Handy Book for Brewers. By HERBERT EDWARDS WRIGHT, M.A. Third Edition. London: Crosby Lockwood and Son. 1907.

IN the third edition of this useful text-book the author has introduced many improvements, while keeping the general arrangement of the text unaltered. Modern discoveries which have a bearing upon any question connected with brewing are fully discussed, the work of Buchner and others upon zymase in particular being very carefully summarised, while a synoptic table of the enzymes has been added. The parts of the book which deal with pure chemistry have been considerably enlarged, and the student of brewing may find that the mass of material put before him is somewhat bewildering in its detail. However, the laboratory work with which the practical brewer should make himself familiar is carefully described; a rather fuller account of the use of the polariscope and polarimeter might perhaps be given, although possibly enough is said to enable straightforward determinations to be carried out. The author has been very careful not to dogmatise more than is absolutely necessary when dealing with the many disputed questions which meet the scientific brewer at every turn, and he has produced a safe and trustworthy book for the use of brewing students.

Agglutinants of All Kinds for All Purposes. By H. C. STANDAGE. London: Archibald Constable and Co., Ltd. 1907.

THIS book contains more than five hundred recipes for the

preparation of cements and agglutinants for the most varied purposes. In order to facilitate reference to the recipes they are arranged under the headings of the different trades, the greater number being included in the sections devoted to the building, paper, and textile industries. Most of the recipes have been carefully tested by the author, or, if this has been impossible, he has had satisfactory evidence that they are reliable for the specified purposes, and some of the miscellaneous information relating to the methods and the compositions employed by metal workers and scientific instrument makers might find useful application in the laboratory; thus, valuable suggestions are given for joining rubber-tubing and for soldering glass. The composition of solders of all kinds is shown in a tabulated statement, and the short notes which are added on the characteristic properties of the chief materials employed should enable adaptations of the recipes to be made to suit special requirements.

The Electrolytic Dissociation Theory. By Prof. R. ABEGG, Ph.D. Authorised Translation by CARL L. VON ENDE, Ph.D. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1907.

THIS discussion of the results of Arrhenius's fruitful theory of electrolytic dissociation by one of the most distinguished of his disciples is a brilliant piece of work, and although it contains comparatively little that is new to students of the great Swedish physicist's own writings, it presents facts and works out formulæ in a very striking and lucid manner. It was hardly to be expected, perhaps, that full justice would be done to the work of the opponents of the theory, although criticisms of it which seem to carry weight are briefly surveyed. Stress is laid upon deductions from the theory and problems for which it seems like to provide a solution, and the development of equilibrium relations among electrolytes is treated specially fully. The book is one which students of physical chemistry will find it profitable to study and thoroughly digest; and even if they have already made themselves acquainted with the outlines of the theory they will find that this masterly little work will put before them fresh aspects of the subject.

Technische Anwendungen der Physikalischen Chemie. ("Technical Applications of Physical Chemistry"). By Dr. KURT ARNDT. Berlin: Mayer and Müller. 1907.

THE technical applications of the most important results which have been obtained owing to the activity of investigators of the laws of physical chemistry are discussed in this book from an elementary point of view. Since there are many text-books dealing with technical electrochemistry the author has touched upon this branch only very lightly, and, on the other hand, devotes much space to the subjects of solution and catalysis. The measurement of high temperatures and the construction of various types of pyrometers are considered in detail, and in all cases the processes employed commercially are described more fully than the laboratory experiments upon which they were based; students in technical schools and colleges, however, who have some knowledge of theoretical physical chemistry will find that the book provides for them an admirable account of the more important applications.

Fuel, Water, and Gas Analysis for Steam Users. By JOHN B. C. KERSHAW, F.I.C. London: Archibald Constable and Co., Ltd. 1907.

THE time must surely be at hand when the steady flow of books of this nature will begin to show signs of abatement—books that are excellent in themselves, and are apparently generally appreciated, but are written for a class that should not exist, namely, those who with quite insufficient scientific training undertake the work of skilled chemists, upon whom they often bring discredit by their incapacity. The engineer or steam user who requires directions for using a chemical balance will, it is hoped, soon be extinct, but in the meantime one who requires instruction of this nature cannot do better than to get this book. Although much of the analytical work is described in a very condensed form, which might lay pitfalls for the uninitiated, the value of the book is not inconsiderable in that it discusses in a broad spirit the practical applications of the test results, and emphasises the importance of the regular testing of materials, showing how the facts thus brought to light may be the means of decreasing expenditure or increasing efficiency. The work will, no doubt, meet with the approbation of steam users, and will give them some insight into analytical methods; it has been carefully written and well printed, although we notice a very misleading illustration of a burette reading on p. 75, the true value differing from that indicated by 0·02 cc.

Die Physik Roger Bacos. ("The Physics of Roger Bacon"). By SEBASTIAN VOGL. Erlangen: Junge und Sohn. 1906.

THIS reprint of the author's inaugural dissertation for the doctorate contains a concise account of Roger Bacon's work on physical subjects, besides a short biography in which are related the main facts known about his life. The discussion of the authorities from whom he acquired his knowledge of physical phenomena includes brief notices of the early philosophers of Greece, Italy, and Arabia, and the writings of Bacon are quoted freely in order to illustrate as clearly as possible the originality and critical faculties he brought to bear upon the various questions which he investigated; it is shown that, although much of his work was of the nature of a compilation, the thirteenth century compiler was surrounded by difficulties with which his brother of the twentieth century does not have to contend. The chemical work of Bacon and his extraordinary belief in the powers of the philosopher's stone are not discussed, but the pamphlet gives a careful and well planned account of his physical work, more especially in the region of optics.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 19, May 13, 1907.

Action of Fluorine on Selenium. Selenium Tetrafluoride.—Paul Lebeau.—By subjecting selenium to the action of fluorine in a glass apparatus, Prideaux obtained a gaseous compound which he thought was selenium hexafluoride, SeF_6, basing the formula upon the density and the physico-chemical relations with the hexafluorides of sulphur and tellurium. However, the readiness with which fluorine forms oxyfluorides in presence of glass led the author to repeat these experiments, using a metal apparatus instead of glass. The selenium was placed in a copper tube connected at one end with the fluorine apparatus and at the other with a system of condensers cooled by liquid air. By this method a very small quantity of gas was obtained, but a colourless fuming liquid collected in the copper tube. This liquid attacks glass energetically, boils at about 100°, and decomposes with water, giving a solution which contains selenious acid and hydrofluoric acid. The compound can thus be analysed by dissolving a known weight in water and determining the fluorine and selenium in the solution. The formula is thus

found to be SeF_4. Sulphur, arsenic, boron, silicon, and carbon are not attacked by the tetrafluoride at its boiling-point; phosphorus sets selenium free, and phosphorus pentafluoride is formed. Selenium tetrafluoride is decomposed by the alkali metals, and attacks mercury at the ordinary temperature. The gaseous compound described by Prideaux is no doubt an oxyfluoride of selenium.

Spontaneous Oxidation of Hydrate of Cobalt in an Alkaline Medium.—André Job.—Although cobaltous compounds do not as a rule readily yield the corresponding cobaltic compound, hydrate of cobalt undergoes a change in air, absorbing oxygen. If equal volumes of the following solutions are mixed—sodium tartrate (50 per cent), cobalt sulphate (30 per cent), and soda (30 per cent)—the cobalt hydrate which is precipitated rapidly dissolves, and a violet-pink liquid is obtained, which turns green when shaken up with air or oxygen. The author found that the amount of gaseous oxygen absorbed increases indefinitely, while that taken up by the cobalt is limited. Hence the organic medium must take part in the reaction, reducing the green compound and keeping one part of the cobalt in the dissolved state, so that it constantly oxidises and gives up oxygen. The addition of glycerin stops this action, and thus renders the green compound much more stable. When glycerin is added (half a volume to one volume of tartrate), the absorption of oxygen by the liquid attains a finite limit, this being raised by increasing the amount of alkali added to the cobalt. Volumetric analysis (by iron pyrophosphate) shows that one atom of oxygen is fixed by two atoms of cobalt, and thus the compound obtained has the formula Co_2O_3. But the volume of gas shows that two atoms of oxygen are absorbed. Hence the organic medium must take up oxygen thus:—$2CoO + O_2 = 2CoO_2$, $2CoO_2 + A = Co_2O_3 + AO$. The oxide CoO_2 has been prepared; and it is found, moreover, that when manganese is substituted for cobalt, the oxide MnO_2 is primarily formed and a manganic salt (Mn_2O_3) exists after the oxidation.

Silicates of Alumina and Lime.—O. Boudouard.—The study of the fusibility of alumino-calcic silicates shows that there are two culminating points in the surface of fusibility corresponding to the temperatures 1510° and 1500°; the composition of these silicates is $SiO_2.Al_2O_3.2CaO$ and $SiO_2.Al_2O_3.8CaO$. To determine whether the first is actually a compound, it was subjected to a microscopic study, and was also analysed chemically, and the agreement between the values calculated and found was so close that there can be no doubt that the compound $SiO_2.Al_2O_3.2CaO$ exists.

Constitution and Properties of Boron Steel.—Léon Guillet.—Already noticed.

Condensation of Oxalic Ethers with Tertiary Aromatic Amines.—A. Guyot.—At a low temperature, in presence of a small quantity of aluminium chloride, oxalic ethers condense with tertiary amines, thus—

$$CO_2R—CO_2R + C_6H_5—NR'_2 = ROH + R'_2N—C_6H_4—CO—CO_2R.$$

With more aluminium chloride, or at a high temperature, the equation is—

$$CO_2R—CO_2R + 2C_6H_5—NR'_2 = ROH + \begin{matrix} R'_2N—C_6H_4 \\ R'_2N—C_6H_4 \end{matrix} > COH—CO_2R.$$

At a still higher temperature, or in presence of a large excess of aluminium chloride, the ether of a hexamethyltriamidotriphenylacetic acid is obtained:—

$$CO_2R—CO_2R + 3C_6H_5—NR'_2 = ROH + H_2O + \begin{matrix} R'_2N—C_6H_4 \\ R'_2N—C_5H_4 \\ R'_2N—C_6H_4 \end{matrix} > C—CO_2R.$$

The author finds that all amines and ethers he has investigated possess this property. With sulphuric acid these condensation products give quantitatively $R_2N—C_6H_4—COOH$, $R_2N—C_6H_4—CO—C_6H_4—NR_2$, and $(R_2N—C_6H_4)_3\equiv C—OH$, which are the substances formed when phosgene gas reacts with tertiary aromatic amines, and which are of technical importance as derivatives of triphenylmethane.

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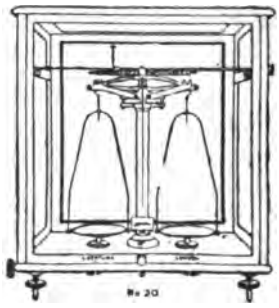

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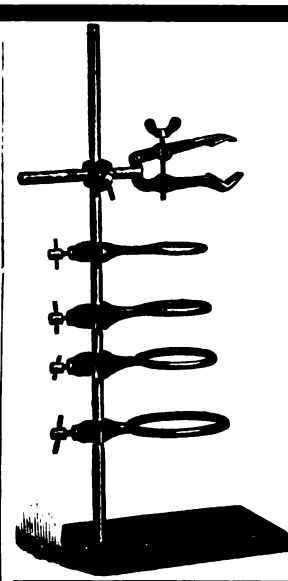

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ON THE

DISCHARGE OF NEGATIVE ELECTRICITY FROM HOT CALCIUM AND FROM LIME.*

By FRANK HORTON, D.Sc., B.A., Fellow of St. John's College, Cambridge.

THIS paper contains an account of some experiments in which the negative leak from hot calcium was compared with that from platinum and from lime under similar conditions. The experiments were conducted in an atmosphere of argon or helium at a few millimetres pressure. The method of experimenting was as follows:—The negative leak from a platinum strip, heated by an electric current, was first investigated. The temperature of the strip was indicated by a thermocouple of wires of platinum and platinum with 10 per cent of rhodium, and the leak was measured by a delicate d'Arsonval galvanometer. Without changing the apparatus, the cathode was covered with metallic calcium by sublimation from an electrically heated calcium wire situated in the discharge tube near to the cathode. The negative leak from the calcium-covered cathode was determined at different temperatures. Some pure oxygen was then let into the apparatus and the calcium on the cathode was oxidised to lime. The excess of oxygen was then removed and the negative leak again measured. Finally, hydrogen was let into the apparatus and the effect of this gas on the negative leak from lime was investigated.

The results contained in the paper may be summarised as follows:—

1. The experiments with a platinum cathode showed that the negative leak from platinum in helium or argon at low pressures is practically the same as in air or oxygen. The variation of the negative leak per square centimetre with the temperature of the cathode can be expressed by an equation of the form used by O. W. Richardson and by H. A. Wilson, viz., $x = A\theta^{1/2}e^{-Q/2\theta}$, where x is the current in ampères, θ the absolute temperature, and Q and A are constants.

2. The negative leak from calcium is enormously greater than from platinum at the same temperature. As with platinum, the variation of the leak with temperature can be expressed by the above equation, but the values of the negative leaks from calcium at different temperatures do not so closely agree with the values calculated from the equation as in the case of platinum. This is probably due to the greater experimental difficulties attending the use of calcium.

3. On oxidising the calcium on the cathode to lime there is an enormous increase in the negative leak, the leak from a lime cathode at 950° C. being about the same as the leak from calcium at 1400° C. The variation of the negative leak from lime with the temperature is not constant, but slowly decreases with continued heating.

4. The negative leak from lime in hydrogen is much greater than that in air or helium.

Since calcium is a much more electro-positive metal than platinum, it was to be expected that the negative leak from calcium would be greater than that from platinum at the same temperature. It would also be expected that the negative leak from calcium would be greater than that from lime under similar conditions; for in the case of lime we should expect the presence in the molecule of the electro-negative atom of oxygen to act as an attracting force tending to retain the escaping corpuscle. The present experiments, however, show that the negative leak from lime is greater than that from calcium. It is interesting to note that the metallic oxides which give the largest emissions of negative corpuscles when heated are the alkaline earths, and it is these also which exhibit most strongly the property of glowing when heated to a high temperature. It is not improbable that there is some connection between these two phenomena.

* Abstract of a Paper read before the Royal Society, Jan. 31, 1907.

ON THE THERMO-CHEMISTRY OF FLAME SPECTRA AT HIGH TEMPERATURES.*

By W. N. HARTLEY, F.R.S., D.Sc., Royal College of Science Dublin.

(Continued from p. 268).

PART II.—ON THE CHEMICAL REDUCTION OF THE ALKALINE EARTH SULPHATES.

FOR studying the action of gases in the flame on the insoluble sulphates, the minerals heavy spar, celestine, and selenite were chosen. Pieces of each measuring about 15 × 15 × 2 mm. were held by platinum forceps in the oxy-hydrogen flame for a definite period, and then dropped into a measured volume (50 cc.) of water. The unaltered mineral was insoluble in each case, but that which had undergone reduction, whether to oxide or sulphide, dissolved with a strongly alkaline reaction; the metal in solution was therefore determined volumetrically with standard acid. From the dissolved salts obtained from heavy spar, sulphuretted hydrogen was evolved in large quantity, somewhat less in the case of celestine, and hardly a trace with selenite. The following tabulated statement shows the results obtained:—

Anhydrous salt.	Time in flame.	Metal in solution.	Metal as sulphide.
	Minutes.	Grm.	
$CaSO_4$.. ..	15	0·0436	Practically none
$SrSO_4$.. ..	15	0·1150	10 per cent
$BaSO_4$.. ..	10	0·1055	Practically all
	15	0·1820	

If numbers be taken proportional to the above quantities, they are found to be approximately in the ratio of the atomic weights of the elements, thus:—

0·0436 grm. : 0·115 grm. : 0·182 grm. = 34 : 88 : 139
Ca : Sr : Ba = 40 : 87·5 : 137

A sample of celestine was heated in the flame for thirty-five minutes and dropped into water, acidified with acetic acid, and the sulphuretted hydrogen precipitated as lead sulphide, which was filtered off, converted into lead sulphate and weighed. The excess of lead was removed and the excess of strontium determined as carbonate.

Weight of lead sulphate.. ..	0·0314 grm.
Strontium as SrS	0·0091 „
Strontium carbonate	0·1718 „
Strontium as SrO	0·1022 „

These figures show that 8·1 per cent of the strontium in solution is in the state of sulphide.

The quantity of strontium reduced from sulphate in thirty-five minutes was 0·1022 grm., whereas that reduced in fifteen minutes was 0·115 grm., or the longer period in the flame has yielded the smaller product.

The Reduction of Barium Sulphate to Sulphide by Hydrogen.

A current of dry hydrogen was passed over a weighed quantity of precipitated dried barium sulphate heated to redness in a platinum tube. It was soon observed that sulphuretted hydrogen was evolved, probably according to the equations following:—

$$BaSO_4 + 4H_2 = BaS + 4H_2O \quad . \quad . \quad . \quad . \quad 1.$$
$$BaS + H_2O = BaO + H_2S \quad . \quad . \quad . \quad . \quad 2.$$

* A Paper read before the Royal Society, January 31st, 1907. (Revised March 22nd).

Sulphuretted hydrogen was still being evolved after a period of eight hours, when the experiment was stopped.

$BaSO_4$, initial weight ..	0·3226 grm.	= Ba 0·1897 grm.
$BaSO_4$, residue unchanged	0·0059 „	= Ba 0·0035 „
Diff., substance reduced .	0·3167 „	= Ba 0·1862 „
$PbSO_4$ from BaS, found .	0·2822 „	
Ba in BaS, found	0·1276 „	
Ba in BaO, found	0·0586 „	
Total Ba in $BaSO_4$ reduced	0·1862 „	

The reduced $BaSO_4$ is thus seen to have been composed of BaS = 0·1574 grm. and BaO = 0·0654 grm.; or about two-thirds sulphide and one-third oxide.

There can be no doubt that the initial action of the hydrogen is the reduction of the sulphate to sulphide, and that probably the whole of the sulphate is reduced; the secondary action, whereby the sulphide is converted into oxide with evolution of sulphuretted hydrogen, is slow and gradual with the barium compound, but takes place with greater facility with strontium, and with completeness in the case of calcium.

When heated to bright redness in a platinum tube through which a current of nitrogen and of carbon dioxide is passed, barium sulphate in neither instance undergoes any change.

When submitted to a white heat in a platinum tube at a reduced pressure for fifteen minutes, barium sulphate evolved no oxygen and the substance showed no alkalinity and was quite unchanged.

These experiments show that the hydrogen of the flame is the reducing agent by which the spectra are produced.

Part III.—The Thermo-chemistry of the Reduction Processes in Flame Reactions.

In studying the thermo-chemistry of flames, it is necessary to consider three separate questions:—

1. The effect on compounds of high temperatures solely.
2. The chemical action of other reacting substances in the flame gases on the compound in the flame.
3. The combined effect of high temperatures and reducing gases.

The thermo-chemical notation used is that of Dr. James H. Pollok (*Sci. Proc. Roy. Dublin Society*, 1899; *Trans. Chem. Soc.*, 1904, lxxxv., 603). The solid, liquid, gaseous, and dissolved states are indicated where necessary by a dot, dash, T, or circle (· — T o) placed below the formula of the substance. The heat evolved in the formation of a compound is indicated by ξ placed before its formula, which signifies *energy*.

The heat of a reaction is indicated by enclosing the equation in brackets and placing ξ before it. K° signifies a kilogrm. degree of heat or large calorie, *k*° similarly is a grm. degree of heat or small calorie. The chemical formula for a substance means, as is usual in this connection, its grm.-molecular weight.

(For the convenient symbol g° C., or grm.-degrees Celsius, instead of heat units or calories, and kilogrm. degrees of heat, K° C., we are indebted to Mr. J. Y. Buchanan, "On Steam and Brines," *Trans. Roy. Soc. Edin.*, 1894, xxxix., Part III., 529).

In discussing the process of hydrolysis of alkaline chlorides in the flame, we must take into account the following values and place the reaction at a temperature approaching 2000°, then—

$$\xi HCl = 26 \text{ K}^{\circ} \text{ and } \xi H_2O = 50{\cdot}6 \text{ K}^{\circ}.$$

The heat of formation of solid potassium and sodium hydroxides is thus represented—

$$\xi(K + H + O = KOH) = 104{\cdot}6 \text{ K}^{\circ};$$
$$\cdot \quad T \quad T \quad \cdot$$

similarly,—

$$\xi NaOH = 102{\cdot}7 \text{ K}.$$

The hydrolysis is then—

$$\underset{105{\cdot}7}{\xi(KCl} + \underset{50{\cdot}6}{H_2O} = \underset{104{\cdot}6}{KOH} + \underset{26}{HCl}) = -25{\cdot}7 \text{ K}^{\circ}.$$

The corresponding value for NaOH is −19·8 K°.

These reactions are not very strongly endothermic and therefore may occur and are reversible.

Among the common salts of lithium, the sulphate has the greatest stability, nevertheless in a gas flame it is reduced to oxide. Fused lithium sulphate was found to be a perfectly neutral substance, but when a bead of the salt had been heated in the flame of a Mecke burner for an hour it yielded a strongly alkaline solution which did not evolve sulphuretted hydrogen when acidified, nor did it effervesce. It therefore contained the oxide. On taking a larger mass and heating it on kyanite in the oxy-coal-gas blowpipe flame, care being taken that there should be no free carbon, the fused salt became reduced to sulphide. From this it appears that the normal process of reduction of the sulphates in the flame is that given in the two equations referring more particularly to barium sulphate. The difference in the heat of formation of lithium oxide and sulphide respectively, $\xi Li_2S = 115{\cdot}4$ K° and $\xi Li_2O = 141{\cdot}2$ K°; this shows how readily the former may be converted into the latter by the action of water-vapour, $\xi H_2O = 69$ K°, by reason of its being an exothermic action.

The flames from coal-gas, hydrogen, and carbon monoxide respectively, when burning in air, have a temperature as high as that of the melting-point of platinum, 1775° C. This temperature exceeds that of the metallurgical furnaces, in which sodium, potassium, cadmium, zinc, and magnesium are reduced and distilled on an industrial scale.

In the manufacture of sodium and potassium from the respective carbonates by means of carbon, the oxide is vaporised and chemically dissociated, thus $Na_2O = 2Na + O$, but the reaction is not reversible, owing to the presence of carbon, which immediately forms carbon monoxide with the oxygen, thus—

$$\xi(C + O = CO) = 29{\cdot}4 \text{ K}^{\circ} \text{ and } \xi(CO + O = CO_2) = 68{\cdot}3 \text{ K}^{\circ};$$

therefore, on the whole we have—

$$\xi CO_2 = 97{\cdot}4 \text{ K}^{\circ}.$$

But—

$$\xi Na_2O = 100{\cdot}2 \text{ K}^{\circ} \text{ and } \xi K_2O = 98{\cdot}2 \text{ K}^{\circ},$$

so that where the carbon is oxidised to carbon monoxide only, we have a considerable endothermic action, thus—

$$\xi(Na_2O + C = CO + 2Na) = -71{\cdot}4 \text{ K}^{\circ}, \text{ endothermic.}$$

Although this equation does not take into account the fact that the Na_2O is already dissociated, this endothermic action may easily tend towards an exothermic character by the further combustion of the carbon monoxide to carbon dioxide, thus—

$$\underset{200{\cdot}4}{\xi(2Na_2O} + C = 4Na + \underset{97{\cdot}6}{CO_2}) = \underset{\text{Endothermic}}{-102{\cdot}8 \text{ K}^{\circ}},$$

or for one atom of oxygen −51·4 K°.

If we suppose the operation to be a simple one of reduction, we have—

$$\underset{270{\cdot}8}{(Na_2CO_3} + 2C = 2Na + \underset{29{\cdot}4 \times 3}{3CO}) = -82{\cdot}6 \text{ K}^{\circ}.$$

The reduction of K_2CO_3 in like manner would result in an endothermic value of −90·6 K°. The same reasoning does not apply to lithium oxide, for all attempts to obtain lithium by a similar process of reduction have entirely failed. The reason is, that lithia more nearly resembles the alkaline earth oxides in its chemical properties; it is also the least volatile and least fusible of the alkali group; moreover, the energy required for its reduction is greater than that necessary for potassium or sodium. Thus,—

$$\xi Li_2O = 141{\cdot}2 \text{ K}^{\circ} \text{ and } \xi Na_2O = 100{\cdot}9 \text{ K}^{\circ}.$$

An important fact may be observed here, namely, that whereas the banded spectrum of potassium is comparatively easy to obtain, that of lithium is very difficult, more diffi-

cult than that of sodium, and even the continuous rays are very weak. The same must be said of rubidium, with the additional remark that its band spectrum has never yet been seen. (A note appears on one of my photographs that there are just faint indications of bands in the strong continuous spectrum). This, undoubtedly, in part arises from the high value for the heat of formation of the oxides of these metals, and it is obvious that these particular properties of lithium serve to explain why the continuous glow observed by Lenard in the case of lithium is weaker than that of either sodium or potassium, which led him to remark that it was probably a property peculiar to that element. Even rubidium carbonate was reduced by mixing with carbon and heating to a particularly high temperature (Bunsen), but the greater volatility of rubidium compounds may facilitate their dissociation.

It is quite evident, then, that with the fusible and volatile oxides of sodium, potassium, and rubidium, reduction can be effected at a temperature not exceeding a white heat, and probably about 1400° C., certainly below the temperature of melting platinum, and below the highest temperatures of the coal-gas, the hydrogen, and the carbonic oxide flames.

Hence I conclude that the banded spectra of lithium, sodium, and potassium observed at the temperature of the oxyhydrogen flame are the spectra of the metals.

(To be continued).

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

Part II.—Analysis of the Silver, Copper, and Tin Groups.

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 272).

Confirmatory Experiments and References.

Analysis of the Silver Group.

P. 11, N. 1: *Solubility of* $PbCl_2$ *and* TlCl *in Water and in* HCl.—See Noyes (*Zeit. Phys. Chem.*, 1892, ix., 614, 623); Engel (*Ann. Chim. Phys.*, 1889, [6], xvii., 359); Ditte (*Comptes Rendus*, 1881, cxii., 718).

P. 13, N. 1: *Solubility of* $PbSO_4$.—See C. E., P. 26, N. 1.

*P. 13*a*, N. 1: *Test for Thallium with* KI.—To 50 mgrms. Pb as $PbCl_2$, dissolved in 20 cc. water, 5 cc. H_2SO_4 (1·84) were added; the mixture was cooled and filtered, and to the filtrate a few drops KI solution were added; no precipitate appeared. The experiment was repeated, except that 1 mgrm. Tl as Tl_2SO_4 was also present; a pale yellow precipitate of TlI resulted.

To solutions containing 0·5 mgrm. Tl as Tl_2SO_4 and 4 cc. HCl (1·12), and 10 cc. or 20 cc. water respectively, a few drops of a normal KI solution were added; a yellow precipitate separated in the first experiment, but only a faint yellow turbidity appeared in the second.

*P. 13*a*, N. 2: *Oxidation of Thallous Salts.*—100 mgrms. Tl as Tl_2SO_4 were dissolved in 10 cc HNO_3 (1·42) and evaporated to about 2 cc.; the solution was diluted to 20 cc., and 1 to 2 cc. HCl (1·12) added; a large light yellow precipitate separated, thus showing that some, but not much, of the thallium had been oxidised.

100 mgrms. Tl as Tl_2SO_4 were dissolved in 2 cc. HNO_3 (1·42), and about 5 cc. HCl (1·20) were added; a white precipitate separated at first, but dissolved on warming. The mixture was evaporated to about 2 cc., cooled, and diluted to 20 cc.; no precipitate separated, even when a little HCl was added, thus showing that the thallium was in the thallic state. The experiment was repeated, except that the aqua regia solution was evaporated to dryness, and the residue dried by heating slightly; to it 4 cc. HCl (1·12) and 20 cc. water were added; a large light yellow precipitate separated, showing that the thallic salt had been largely, but not completely, reduced.

P. 14, N. 1: *Explanation of the Solubility of* $PbSO_4$ *in Ammonium Acetate Solution.*—See Noyes and Whitcomb (*Journ. Am. Chem. Soc.*, 1905, xxvii., 747).

P. 14, N. 2: *Behaviour of Bismuth Compounds towards Ammonium Acetate and* K_2CrO_4.—Five mgrms. Bi as solid bismuth oxysulphate (see P. 26, N. 5) were treated by P. 14, 20 cc. normal ammonium acetate and 5 cc. 5 normal acetic acid being used; a yellow precipitate very similar in appearance to $PbCrO_4$ was formed on the addition of K_2CrO_4, but this dissolved quickly in the acetic acid. The experiment was repeated with 1 mgrm. Bi as nitrate; the result was the same.

P. 15, N. 1: *Molecular Formula of Gaseous Mercurous Chloride.*—Baker (*Journ. Chem. Soc. Trans.*, 1900, lxxvii., 646) has shown that absolutely dry mercurous chloride vapour has a density corresponding to the formula Hg_2Cl_2.

Condition of Mercurous Salts in Solution.—See Ogg (*Zeit. Phys. Chem.*, 1898, xxvii., 290—299; Abel (*Zeit. Anorg. Chem.*, 1901, xxvi., 377).

Action of NH_4OH *on* Hg_2Cl_2.—For the evidence that the black residue is a mixture of Hg and $HgClNH_2$, see Barfoed (*Journ. Prakt. Chem.*, 1889, xxxix., 201); Pesci (*Gazz. Chim. Ital.*, 1891, xxi., 569); and Sen (*Zeit. Anorg. Chem.*, 1903, xxxiii., 197).

P. 15, N. 3: *Complex Silver Ammonia Anions.*—See Bodländer and Fittig (*Zeit. Phys. Chem.*, 1902, xxxix., 597); Whitney and Melcher (*Journ. Am. Chem. Soc.*, 1903, xxv., 69); Bodländer and Eberlein (*Zeit. Anorg. Chem.*, 1904, xxxix., 197); Lucas (*Zeit. Anorg. Chem.*, 1904, xli., 193).

P. 15, N. 5: *Solubility of* AgCl *in Chloride Solutions.*—See Comey, ("Dictionary of Solubilities," p. 373).

One mgrm. Ag as AgCl was dissolved in 5 cc. NH_4OH (0·96), the solution obtained was made acid with HCl; no precipitate separated. The experiment was repeated, using HNO_3 instead of HCl; a precipitate formed. Five mgrms. Ag as AgCl were dissolved in 15 cc. NH_4OH (0·96), and the solution made acid with HCl; no precipitate separated. An equal volume of water was added; AgCl precipitated.

Precipitation and Separation of the Copper and Tin Groups.

P. 21, N. 1: *Order of Precipitation of the Sulphides of the Copper and Tin Groups from Cold* HCl *Solution.*—Two mgrms. As as As_2O_3, 2 mgrms. Hg, and 2 mgrms. Cu, each as chloride, were in separate experiments dissolved in 2 cc. HCl (1·20), and 2 mgrms. of each of the elements of the copper and tin groups were in separate experiments dissolved in 4 cc. HCl (1·12); each solution was put into a small bottle, saturated completely with H_2S at room temperature, the bottle corked, and allowed to stand fifteen minutes. In cases where no precipitate formed the solution was successively diluted with measured quantities of water, being again saturated with H_2S, and allowed to stand after each addition; the most strongly acid solution from which each element separated is shown by the following table:—

HCl (1·20).	HCl (1·12).	Water.	Elements precipitated.
Cc.	Cc.	Cc.	
2	..	0	As
..	4	0	Hg, Cu
..	4	4	Sb
..	4	12	Bi, Sn(ic)
..	4	44	Cd
..	4	96	Pb, Sn (ous)

The cadmium, lead, and stannous sulphides precipitated slightly, and only after several minutes; the others almost at once.

Order of Precipitation of the Sulphides of the Iron Group from Weak Acid Solutions.—Fifty mgrms. Zn and 500 mgrms. Zn as nitrate, 500 mgrms. Fe (ous), 500 mgrms. Ni, 500 mgrms. Co, and 500 mgrms. Mn as sulphate were

* From the *Technology Quarterly*, xix., No. 3, September, 1906.

in separate experiments dissolved in 1 cc. HCl (1·12), and 100 cc. water, saturated with H_2S at room temperature, and allowed to stand ten minutes; zinc was precipitated from both its solutions, but none of the other elements. The experiments with 50 mgrms. Zn and 500 mgrms. Zn were repeated, except that 2 cc. HCl (1·12) was used; ZnS precipitated after several minutes in the 500 mgrms. portion, but not in the 50 mgrms. one.

500 mgrms. each of ferrous Fe, Co, Ni, and Mn as sulphate were dissolved in 100 cc. water, and saturated at room temperature with H_2S for ten minutes; FeS slowly precipitated in considerable quantity, but none of the other sulphides.—The experiment was repeated, except that the substances were dissolved in 10 cc. 10 per cent acetic acid solution, 1 cc. 10 per cent $NaC_2H_3O_2$ solution, and 90 cc. water; the result was the same. The last experiment was repeated, except that 10 cc. instead of 1 cc. $NaC_2H_3O_2$ solution was used; large quantities of NiS and CoS as well as of FeS precipitated, but no MnS. In another experiment 500 mgrms. Mn as $MnSO_4$ were dissolved in 1 cc. 10 per cent $HC_2H_3O_2$ solution, 10 cc. 10 per cent $NaC_2H_3O_2$ solution, and 90 cc. water, and saturated with H_2S; no MnS precipitated.

P. 21, N. 3: *Precipitation of Arsenic, Platinum, and Molybdenum by* H_2S.—100 mgrms. As as H_3AsO_4, 100 mgrms. Mo as H_2MoO_4, and 25 mgrms. Pt as H_2PtCl_6 were dissolved in separate 100 cc. portions of dilute HCl, one volume HCl (1·12) to twenty-five volumes water, and were saturated with H_2S in the cold; less than 1 mgrm. of As and of Pt, but considerable Mo precipitated as sulphides in ten minutes. The three solutions were then filtered, heated to boiling, and saturated with H_2S, at that temperature for about fifteen minutes; a large precipitate resulted in each case. The solutions were filtered, saturated in the cold with H_2S, and heated in pressure bottles in the steam-bath for one hour; a considerable precipitate separated from each solution, estimated to contain about 5 mgrms. As in the arsenic solution, and 10 mgrms. Mo in the molybdenum solution.

100 mgrms. As as H_3AsO_4 were added to 100 cc. HCl (1·20), and saturated in the cold with H_2S; a large yellow precipitate separated. After five minutes the mixture was diluted with half its volume of water, and filtered; the filtrate was heated to 100°, and H_2S passed in for ten minutes; a small precipitate estimated to contain only 3 to 5 mgrms. As resulted. These two experiments with arsenic acid show that the precipitation takes place much more rapidly in the presence of concentrated HCl.

Precipitation of Cadmium and Lead by H_2S.—Separate solutions containing 5 mgrms. Cd, 5 mgrms. Pb, 10 mgrms. Cd, and 10 mgrms. Pb, respectively, in 100 cc. of a mixture of one volume HCl (1·12) and fifteen volumes water, were saturated in the cold with H_2S for fifteen minutes; precipitates began to form only after ten or fifteen minutes in each of the solutions.

Separate solutions containing 1 mgrm. Cd and 1 mgrm. Pb in 100 cc. of a mixture of one volume HCl (1·12), and twenty-five volumes water were saturated in the cold with H_2S; both solutions showed precipitates, but that in the case of lead was scarcely visible until it was collected on a filter. The PbS was filtered out, and NH_4OH and $(NH_4)_2S$ added to the filtrate; a brown colour corresponding to 0·1 to 0·2 mgrm. Pb resulted, showing that substantially all the lead was precipitated.

Precipitation of Zinc by H_2S.—Solutions containing 500 mgrms. Zn in three 100 cc. portions of dilute HCl, containing one volume HCl (1·12) to twenty-five volumes water, to forty volumes water, and to fifty volumes water, respectively, were saturated in the cold with H_2S, then heated to boiling, and again saturated with H_2S; in the cold, H_2S failed to produce a precipitate in any of the solutions in five minutes; but on heating, a slight precipitate formed in the 1 : 40, and a heavy one in the 1 : 50, but none in the 1 : 25 mixture.

Precipitation of Titanium Hydroxide by Hydrolysis.—Separate 100 mgrm. portions of Ti in 100 cc. dilute HCl, containing one volume HCl (1·12) to twenty volumes water, to ten volumes water, and to eight volumes water, respectively, were saturated cold with H_2S, and then heated in pressure bottles in a steam-bath for two hours; in the 1 : 20 volume solution a very large white precipitate had formed in thirty minntes; the 1 : 10 solution remained clear for forty-five minutes, and then showed only a turbidity; and the 1 : 8 solution remained unchanged during the two hours.

Precipitation of Bismuth and Antimony Oxychlorides by Water.—Separate solutions containing 500 mgrms. Bi as nitrate, 400 mgrms. Sb as $SbCl_3$, and 300 mgrms. Sb as Sb_2O_5 (obtained by evaporating an $SbCl_3$ solution with aqua regia) were evaporated with HCl almost to dryness; 4 cc. HCl (1·12) and 36 cc. water were added, and the mixture was heated; from the bismuth solution no precipitate separated either in the cold or upon heating; in the antimonous solution a large white precipitate formed in the cold, but dissolved almost completely upon heating, and in the antimonic solution a large precipitate separated in the cold, and did not appear to dissolve upon heating. To the bismuth solution 20 cc. more water were added; a white precipitate then began to form.

P. 21, N. 3; *Separation of the Copper and Tin Groups from the Iron Group by* H_2S.—Mixtures of elements as shown below were dissolved in 4 cc. HCl (1·12) and 36 cc. water, and treated exactly as described in P. 21, except that the solutions containing cadmium were diluted at once to 100 cc., and saturated at room temperature with H_2S; the solutions were filtered after ten to thirty minutes, the filtrate boiled to expel H_2S, HNO_3 added, the mixture again boiled, NH_4OH added to detect iron, any precipitate filtered off, and H_2S was passed into the filtrate, or $(NH_4)_2S$ was added to it to detect zinc, nickel, or cobalt; the results are recorded below as in the Test Analyses:—

Cd	500 —	500 —	500 —	500 —	500 —
Zn	0 S	2 S	1 S (*a*)	..	..
Fe	0 S	..	..	2 S	1 S
Ni	0 S	..	..	..	1 S
Cu	500 —	500 —	..	..	..
Bi	..	..	200 —	200 —	..
As (ous) ..	..	..	100 —	100 —	..
Sb (ous) ..	..	..	100 —	100 —	..
Sn (ic) ..	..	..	200 —	200 —	..
Zn	..	..	1 S (*a*)	..	..
Fe	1 S	0 S	..	..	..
Ni	1 S	..	..	1 S	..
Co	..	1 S (*b*)	..	..	..

(*a*) A nearly white precipitate was obtained with $(NH_4)_2S$.

(*b*) The black $(NH_4)_2S$ precipitate was dissolved in aqua regia, and the solution evaporated just to dryness; th residue had a slight pink colour.

P. 21, N. 4: *Composition of the* H_2S *Precipitates.*—From solution of $HgCl_2$ in excess, see Rose (*Pogg. Ann.*, 1828, xiii., 64). From arsenic acid solutions, see C. E., P. 44, N. 1, 2, and 3. From antimonic solutions, see Klenker (*Journ. Prakt. Chem.*, 1889, lix., 150). From chloroplatinic acid, see Antony and Lucchesi (*Gazz. Chim. Ital.*, 1896, xxvi., 211). From gold chloride, see Hoffmann and Krüss (*Ber.*, 1887, xx., 2369, 2704). From selenous acid, see Ditte (*Comptes Rendus*, 1871, lxxiii., 625, 660); Divers and Shimidzu (*Journ. Chem. Soc.*, 1885, xlvii., 441). From tellurous acid, see Becker (*Liebig's Ann. Chem.*, 1875, clxxx., 260).

P. 21, N. 5: *Action of* HNO_3 *on* H_2S.—Separate 50 cc. portions of mixtures of one volume of HNO_3 (1·20) in 2·5, 5, 10, and 20 volumes of solution were heated to boiling, and saturated with H_2S at that temperature; in the first solution a precipitate of sulphur soon appeared, in the second a slight precipitate formed after ten minutes, and in the last two no precipitates formed in twenty minutes.

P. 22, N. 1: *Solubility of* SnS *and* Sb_2S_3 *in Ammonium Monosulphide.*—See C. E., P. 22, N. 4.

P. 22, N. 2: *Hydrolysis of the Alkaline Sulphides and Composition of the Polysulphides.*—It has been shown by C. F. Sammet (Thesis, Massachusetts Institute of Technology, 1903) that a solution of the empirical composition $(NH_4)_2S$ containing 0·1 formula weight per litre is practically completely hydrolysed into NH_4OH and NH_4SH, and that in the same solution the latter is only slightly (roughly, 0·3 per cent) hydrolysed into H_2S and a second equivalent of NH_4OH. But in a solution containing only half as much NH_4OH, *i.e.*, in a solution containing 0·1 formula weight NH_4SH per litre, the degree of hydrolysis increases to several per cent.

Küster and Heberlein (*Zeit. Anorg. Chem.*, 1905, xliii., 71) have found Na_2S in a solution containing 0·05 formula weights per litre to be 86 per cent hydrolysed into NaOH and NaSH, and NaSH in 0·01 normal solution to be only 0·15 per cent hydrolysed into NaOH and H_2S. For the degree of hydrolysis of NaSH, Walker (*Zeit. Phys. Chem.*, 1900, xxxii., 137) found practically the same value by an independent method.

Küster and Heberlein also investigated the hydrolysis of the polysulphides of sodium, and showed that the degree of hydrolysis decreases with increasing sulphur content; thus a solution of the composition Na_2S_2 with 65 per cent, a solution of Na_2S_4, only 12 per cent hydrolysed. They found further that Na_2S solutions of the following concentrations when saturated with sulphur at 24° have the empirical composition Na_2S_x where x has the following values:—

Formula weights Na_2S per litre .	2·0	½	¼	⅛
Value of x	4·48	4·84	5·12	5·24

It was found that x varied only slightly with the temperature. According to these authors, Na_2S_4, and less readily Na_2S_5, have been obtained in the solid form by evaporating aqueous solutions; but Na_2S_2 and Na_2S_3 have not been so obtained. All of these have, however, been crystallised from alcoholic solutions (H. Boettger, *Liebig's Ann. Chem.*, 1884, ccxxiii., 335; H. Rebs, *Liebig's Ann. Chem.*, 1888, ccxlvi., 358).

Bloxam (*Journ. Chem. Soc.*, 1894, lxvii., 300; 1900, lxxvii., 753) found that a very concentrated ammonium sulphide solution prepared from NH_4OH (0·88) so as to have exactly the composition $(NH_4)_2S$ dissolved sulphur until the composition became approximately $(NH_4)_2S_{4·5}$. He has obtained under various special conditions the following solid salts:—$(NH_4)_2S_4$, $(NH_4)_2S_5$, $(NH_4)_2S_7$, $(NH_4)_2S_9$, $(NH_4)_4S_7$, and $(NH_4)_4S_9$; Na_2S, NaSH, Na_2S_5, and Na_4S_9; K_2S, KSH, K_2S_3, K_2S_4, K_2S_5, K_4S_5, and K_4S_9.

P. 22, N. 2: *Ammonium Salts of the Sulpho-acids.*—The following ammonium sulpho-salts have all been prepared in the crystalline form by adding alcohol to concentrated solutions of the sulphides in ammonium sulphide:—$(NH_4)_3AsS_3$ and $(NH_4)_3AsS_4$ (Berzelius, *Pogg. Ann.*, 1826, vii., 141 and 18); $(NH_4)_3SbS_3$ (Pouget, *Ann. Chim. Phys.*, 1899 [7], xviii., 532); $(NH_4)_3SbS_4$, $(NH_4)_3SbS_4.4H_2O$ (Stanek, *Zeit. Anorg. Chem.*, 1898, xvii., 121); $(NH_4)_3SnS_3.3H_2O$ and $(NH_4)_3SnS_3.7H_2O$ (Stanek, *loc. cit.*, p. 213). Certain other arsenous salts, including NH_4AsS_2, have also been prepared in the solid state. On evaporating a solution of Sb_2S_3 in $(NH_4)_2S$ in a vacuum at a low temperature, the meta salt, NH_4SbS_2, is usually obtained; on evaporating at a high temperature, or on treating NH_4SbS_2 with water, solid $(NH_4)_2Sb_4S_7$ is formed. Berzelius states that a solution of the empirical composition $(NH_4)_2S$ saturated with As_2S_3 or As_2S_5 contains these substances in the proportion $As_2S_3 : 2(NH_4)_2S$ or $As_2S_5 : 2(NH_4)_2S$. Pouget finds that a solution of $(NH_4)_2S$ saturated with Sb_2S_3 contains less antimony than corresponds to the ratio $Sb_2S_3 : 3(NH_4)_2S$. A K_2S or Na_2S solution dissolves sufficient Sb_2S_3 to give a solution of the composition $Sb_2S_3 : 2K_2S$ or $Sb_2S_3 : 2Na_2S$. There does not appear to be any direct evidence as to the nature of these salts in solution.

*Solid sulpho-salts of the rare elements have been obtained from alkaline sulphide solutions as follows:—K_3AuS_3 (Antony and Lucchesi, *Gazz. Chim. Ital.*, 1896, xxvi., 359); $3K_2S.TeS_2$, $3Na_2S.TeS_2$, and $3(NH_4)_2S.TeS_2$ (Berzelius); K_2MoS_4, $(NH_4)_2MoS_4$ (Berzelius, *Pogg. Ann.*, 1826, vii., 429; Krüss, *Liebig's Ann. Chem.*, 1884, ccxxv., 29).

P. 22, N. 4: *Solubility of the Sulphides of the Tin and Copper Groups in Ammonium Hydroxides, Monosulphide, and Polysulphide.*—500 mgrms. As as As_2S_3, Sb as Sb_2S_3, Sn as SnS, Cu as CuS. Hg as HgS, Cd as CdS, Bi as Bi_2S_3, all freshly precipitated by H_2S, and 500 mgrms. As as As_2S_5, 100 or 500 mgrms. Sb as Sb_2S_5, and 100 or 500 mgrms. Sn as SnS_2 all precipitated from ammonium polysulphide, were warmed (but not enough to cause boiling through escape of gas) in a covered casserole for about five minutes with (i.) 15 to 20 cc. NH_4OH (0·96); (ii.) 10 cc. of the ammonium monosulphide reagent; and (iii.) 10 cc. of the ammonium polysulphide reagent. The solutions were then filtered and the filtrates acidified with HCl. The amount dissolved was estimated from the size and colour of the precipitate, or from the amount of the undissolved residue. The results are given below; the numbers represent roughly the number of mgrms. of the element dissolved, a + sign indicating that this amount dissolved readily, and that probably much more would have dissolved.

	(i.) NH_4OH (0·96).	(ii.) Monosulphide.	(iii.) Polysulphide.
As_2S_3 ..	500 +	500 +	500 +
As_2S_5 ..	500 +	500 +	500 +
Sb_2S_3 ..	0·5—1	50—100	500
Sb_2S_5 ..	100 (*a*)	300	500 +
SnS ..	0 (*b*)	0—3 (*b*)	500
SnS_2 ..	100 (*a*)	300	500 +
CuS ..	0—0·3	0	5—10
HgS ..	3—10	0	1
CdS ..	0	0	0
Bi_2S_3 ..	0	0	0

(*a*) Only about 100 grms. of the element as sulphide was taken in these experiments.

(*b*) A few mgrms. (5 to 15) of a yellow precipitate (SnS_2), containing little or no SnS were precipitated on acidifying the filtrate.

The orange Sb_2S_3 was found to be changed into the black variety, stibnite, by continued treatment with ammonium monosulphide, and black HgS was changed into the red modification by continued treatment with the polysulphide. It was also noted that the HgS which dissolves in NH_4OH may be precipitated by adding a few drops of monosulphide.

500 mgrms. Cu and 500 mgrms. Hg as freshly precipitated sulphides were in separate experiments warmed to 50° or 60° in covered casseroles with 25 cc. ammonium monosulphide for fifteen minutes; the residues were filtered off, and the filtrates made acid with HCl; a slight precipitate of sulphur separated, which was only very slightly darkened, thus showing that only an insignificant quantity of CuS or HgS had dissolved.

An ammonium monosulphide solution was prepared from NH_4OH (0·90) as described in N. 2, except that the solution was not diluted with the equal volume of water. From this solution several different ammonium polysulphide solutions were prepared, containing, respectively, 20, 10, 5, 3, and 1 grms. dissolved sulphur in 200 cc., and their solvent power for SnS and CuS tested as follows:—

500 mgrms. Sn as freshly precipitated SnS were warmed gently in a covered casserole with (i.) 10 cc. of these undiluted solutions; (ii.) 5 cc. of them + 5 cc. water; and (iii.) 5 cc. of them + 10 cc. water. The mixture was stirred frequently with a glass rod. The amount of tin in mgrms. dissolved in a solution containing x grms. dissolved sulphur in 200 cc., and the time required to dissolve it are given below.

	x=10 grms.	x=5 grms.	x=3 grms.	x=1 grm.
(i.) 10 cc. undiluted	500 / 4 mins.	500 / 5 mins.	500 / 15 mins.	100 / 5 mins.
(ii.) 5 cc. + 5 cc. H_2O ..	500 (*a*) / 5 mins.	500 / 10 mins.	.. / ..	100 / 10 mins.
(iii.) 5 cc. + 10 cc. H_2O	500 / 8—10 mins.	.. / ..	.. / ..	.. / ..

500 mgrms. Cu as CuS were similarly treated for five minutes; the following table shows roughly the number of mgrms. Cu as CuS that dissolved in a solution containing x grms. dissolved sulphur in 200 cc. where x has the stated values.

x = grms.... ...	20	10	5	3	1	0
(i.) 10 cc. of solution ..	25 +	..	12	6	0·5	..
(ii.) 5 cc. + 5 cc. H_2O	..	8 (*a*)	4	3	0·2	0
(iii.) 5 cc. + 15 cc. H_2O	..	6—8	..	..	..	..

(*a*) The regular reagent described in N. 2 has this composition.

P. 22, *N. 5: *Solubility of the Sulphides of the Rarer Elements in Ammonium Sulphide.*—Ribau (*Bull. Soc. Chim.*, 1877, xxviii., 241) has shown that pure, freshly precipitated PtS_2 is nearly insoluble in ammonium sulphide, but dissolves in large quantity when mixed with sulphides of either the tin or copper groups. (Under "Test Analyses of the Tin Group" it is shown that small quantities of platinum and gold divide almost equally between the copper and tin groups when copper is also present).

50 mgrms. Mo as freshly precipitated sulphide were digested in a covered casserole at 40—60° with 25 cc. ammonium monosulphide for fifteen minutes; the deep red solution was filtered and acidified with HCl; a precipitate estimated to contain about 35 mgrms. Mo separated. The residue was digested a second time with 25 cc. ammonium monosulphide; only about half the residue dissolved. (The experiment was repeated, using 10 cc. portions of ammonium polysulphide; the result was the same, about two-thirds dissolving in the first treatment and about half the residue in the second).

200 mgrms. Te were freshly precipitated with H_2S from a hot HCl solution containing 4 cc. HCl (1·12) and 36 cc. water; the black precipitate was digested with 25 cc. ammonium monosulphide; the precipitate dissolved completely in three or four minutes. The solution was acidified with HCl; a black precipitate separated. This was digested with 10 cc. ammonium polysulphide; it dissolved immediately. To the solution HCl was added; a black precipitate separated.

200 mgrms. Se as H_2SeO_3 were precipitated by Na_2SO_3 in an HCl (1·12) solution, as in *P. 43*c*. The red precipitate was filtered off and washed with HCl (1·12). It was then dissolved in hot HNO_3 (1·20); the solution was evaporated just to dryness and the residue dissolved in 4 cc. of HCl (1·12) and 36 cc. of water. The solution was heated to boiling and saturated with H_2S. A yellow precipitate which partly changed to red during the precipitation was produced. The solution was diluted to 100 cc. and again saturated with H_2S in the cold; the precipitate was filtered off and digested with 25 cc. ammonium monosulphide; the finely divided portion of the precipitate dissolved in a few minutes, forming a deep red solution, but the larger particles turned black on the surface and dissolved very slowly. After a few minutes the solution was filtered and the black residue digested successively three times with a fresh 25 cc. portion of ammonium monosulphide; finally it all dissolved. The successive sulphide solutions were acidified with HCl (1·12); a bright yellow precipitate formed at first in every case, but that in the first solution gradually became orange within a few hours.

P. 22, N. 6: *Extraction by Ammonium Monosulphide and Polysulphide of Arsenic, Antimony, and Tin Sulphides from those of the Copper Group.*—See "Test Analyses of Tin Group."

Mixtures of 5, 10, 15, and 20 mgrms. Sn as SnS with 500 mgrms. Cd as CdS were digested at 80—90° with the ammonium polysulphide reagent in a pressure bottle for half an hour, and the solutions were analysed by P. 41—47; the results recorded as in the Test Analyses were as follows:—

Cd	500	500	500	500
Sn	5 F	10 F	15 D	20 S

The confirmatory test for tin (P. 47) failed in the experiment with 15 mgrms. Sn. — The experiment was repeated with a mixture of 5 mgrms. Sn as SnS_2 and 500 mgrms. Cd as CdS; a small but satisfactory test for tin was obtained.

P. 22, N. 8: *Coagulation of Colloidal Sulphides by* NH_4NO_3.—In washing the various sulphides of the copper groups after the $(NH_4)_2S$ treatment, CuS, and especially CdS, sometimes passed through the filter in colloidal condition. To these colloidal mixtures was added enough solid NH_4NO_3 to make a 5 per cent solution, and the mixtures were shaken and filtered; the filtrates were clear.

(To be continued).

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

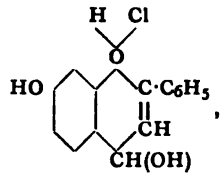
Ordinary Meeting, May 16th, 1907.

Prof. R. Meldola, F.R.S., Past President, in the Chair.

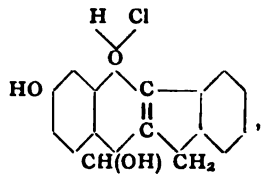
(Concluded from p. 274).

108. "*Some Derivatives of γ-Pyranol allied to certain Derivatives of Brazilein and Hæmatein.*" (Preliminary Communication). By William Henry Perkin, jun., and Robert Robinson.

o-Hydroxybenzaldehyde and its derivatives condense with certain acetophenone or hydrindone derivatives to form derivatives of γ-pyranol. Thus β-resorcylaldehyde and acetophenone condense readily when their solution in acetic acid is saturated with hydrogen chloride, and the *7-hydroxy-2-phenyl-1 : 4-benzopyranol hydrochloride*,—

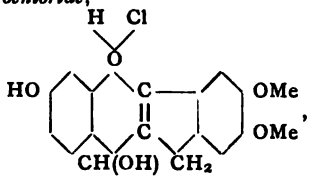


thus produced, is identical with the substance prepared by Bulow and Sicherer (*Ber.*, 1901, xxxiv., 3890) from benzoylacetaldehyde by condensation with resorcinol. If the acetophenone is replaced by 1-hydrindone, *7-hydroxy-2 : 3-indeno-1 : 4-benzopyranol hydrochloride*,—



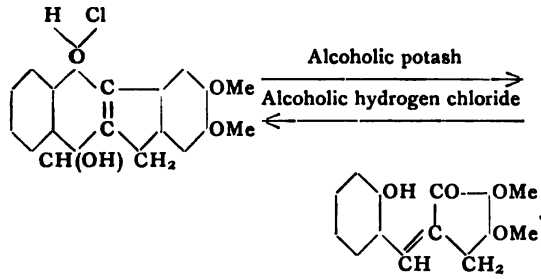
is produced. This substance crystallises with 2 molecules of water and yields, with platinum chloride, the double *salt* $(C_{16}H_{12}O_3,HCl)_2PtCl_4$ and, with gold chloride, the *salt* $C_{16}H_{12}O_3HCl,AuCl_3,H_2O$.

7-Hydroxy-5 : 6-dimethoxy-2 : 3-indeno-1 : 4-benzopyranol hydrochloride,—



is obtained when β-resorcylaldehyde and 5 : 6-dimethoxy-1-hydrindone are condensed by hydrogen chloride in methyl-alcoholic solution. Similar condensations have also been carried out with salicylaldehyde and *p*-methoxysalicylaldehyde and 5 : 6-dimethoxyhydrindone.

The pyranol derivatives thus produced may also be obtained by the action of alcoholic hydrochloric acid on the corresponding *o*-hydroxybenzylidene-1-hydrindones, and, conversely, the latter are again produced from the pyranols by the action of alcoholic potash. The following example will serve as an illustration of these important changes:—



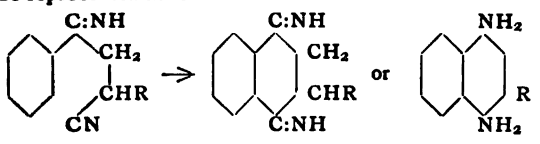
The authors wish to reserve, for a short time, the further investigation of the above and similar condensations.

109. "*Arsenic Di-iodide.*" By JOHN THEODORE HEWITT and THOMAS FIELD WINMILL.

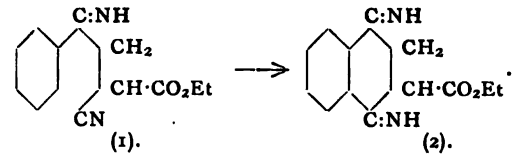
The authors have prepared and analysed the arsenic di-odide described by Bamburger and Philipp (*Ber.*, 1881, xiv., 2643). The molecular weight determined by the elevation of boiling point in carbon disulphide solution shows the compound to have the formula As_2I_4. The substance is, however, useless for the preparation of aromatic analogues of cacodyl, since the only product isolated from the action of magnesium phenyl bromide is triphenylarsine. Pyridine decomposes the compound immediately with liberation of arsenic.

110. "*The Formation and Reactions of Imino-compounds.* Part IV. *The Formation of 1 : 4-Naphthylenediamine from Ethyl γ-imino-α-cyano-γ-phenylbutyrate.*" By JOCELYN FIELD THORPE.

In continuation of the work already published in Parts II. and III. of this series it was shown that derivatives of benzene having a side-chain of three carbon atoms substituted at the α-carbon atom by a nitrile group and at the γ-carbon atom by an imino-group pass, on treatment with cold concentrated sulphuric acid, into derivatives of 1 : 4-naphthylenediamine, ring formation taking place between the ortho-hydrogen atom of the benzene ring in respect to the side-chain and the carbon atom of the nitrile group. The general formula for this reaction can therefore be represented as follows :—

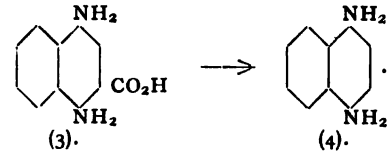


Ethyl γ-imino-α-cyano-γ-phenylbutyrate (1) passes on treatment with cold concentrated sulphuric acid into ethyl 1 : 4-naphthylenediamine-3-carboxylate (2) :—



(1). (2).

This ethyl salt yields 1 : 4-naphthylenediamine-3-carboxylic acid (3) on hydrolysis, from which 1 : 4-naphthylenediamine (4) can be prepared on heating at 200° in a current of hydrogen :—



(3). (4).

111. "*Mercury Derivatives of Pseudo-acids containing the Group* ·CO·NH·." By SAMUEL JAMES MANSON AULD.

Unlike cyanuric acid, which forms two isomeric mercuric salts (Hantzsch, *Ber.*, 1902, xxxv., 2717), all the pseudo-acids containing the group ·CO·NH· examined have given only one derivative, in all cases an N-salt containing the group ·CO·Nhg·. Some of these N-mercury salts act as "mercury acids" and form alkali salts. Violuric acid, for instance, forms a series of coloured alkali mercuriviolurates, which can be obtained both in the hydrated and anhydrous states. The pseudo-acids examined include uric acid and its alkyl derivatives, ψ-uric acid, methyluracyl, violuric and dimethylviolurie acids, saccharin, benzoylcyanamide, and carbostyril.

112. "*The Influence of Substitution in the Nucleus on the Rate of Oxidation of the Side-chains.* III. *Oxidation of the Nitro- and Chloronitro-derivatives of Toluene.*" By JULIUS BEREND COHEN and HENRY JAMES HODSMAN.

The authors have studied the rate of oxidation of the nitro- and chloronitro-toluenes, the same method being employed as that previously described (*Trans.*, 1904, lxxxv., 174, 1622). Excluding the 4-chloro-2-nitrotoluene, which occupies an exceptional position in the series, the general result of the oxidation of the ten isomeric chloronitrotoluenes may be summarised as follows. The compounds with the nitro-group in the ortho-position are least oxidised, those with the nitro-group in the para-position are most oxidised, whilst the meta-compounds stand midway between the two. The same result is obtained with the three isomeric nitrotoluenes. The position occupied by 4-chloro-2-nitrotoluene appears to depend on the length of time during which the substance is in contact with the oxidising agent, the quantity of acid formed varying inversely with the time of oxidation. This has been explained by showing that in all the *o*-nitro-compounds the acid first formed undergoes further oxidation, and that this is especially the case with the 4-chloro-2-nitro-compound. The result is that the quantity of acid as well as the total yield of products is low; in other words, the more protracted the oxidation, the more of the acid, first formed, is destroyed.

The authors also described the preparation of 3-chloro-2-nitrotoluene which was originally obtained by one of them in conjunction with H. G. Bennett, so that all the isomeric chloronitrotoluenes are now known.

113. "*The Reducibility of Magnesia by Carbon.*" (Preliminary Note). By ROLAND EDGAR SLADE.

Three distinct methods were attempted for establishing the reducibility of magnesia by carbon. The first consists in heating magnesia and carbon together in an enclosed furnace, with arc or resistance heating, and collecting and analysing the gaseous products of reaction; considerable quantities of carbon monoxide and some carburised magnesium were in this way obtained.

The second method is an application of that employed by R. S. Hutton and J. E. Petavel (*Proc. Roy. Soc.*, 1907,

A, lxxix., 155) for investigating the reduction of alumina, and consists in employing a bath of molten electrolytic copper as a solvent and condenser for the metal vapour.

These experiments were carried out in carbon tube furnaces and in crucibles heated under the electric arc; alloys of copper and magnesium were obtaind at temperatures as low as 1700°. In the carbon tubes the sublimed magnesia also reacts with the heated walls of the tubes, from which a powder containing carburised magnesium can be collected on cooling.

The third method has not up to the present proved successful, but consists in heating a mixture of magnesia and carbon to known temperatures in a current of nitrogen gas, the product being examined for nitride. The temperature of reduction of magnesia seems to be above the limit of temperature at which the nitride is stable.

The two methods which have furnished a positive result give independent confirmation of the recent experiments of Lebeau (*Comptes Rendus*, 1907, cxliv., 799). Whereas this author considers that the reduction only occurs at or above the boiling point of magnesia when the vapour of carbon and magnesia come in contact, the present research seems to show that the reaction can take place at temperatures below the melting-point of this oxide.

114. "*The Reaction between Organo-magnesium Halides and Nitro-compounds.*" (Preliminary Note). By ROBERT HOWSON PICKARD and JOSEPH KENYON.

Aromatic nitro-compounds react very vigorously with an organo-magnesium halide in ethereal solution.

p-Nitrotoluene thus forms an indefinite amorphous yellow *compound*, which, when treated with acids, yields principally *p*-nitrosotoluene, *p*-tolylhydroxylamine, *pp'*-azoxytoluene (probably by the interaction of the two former compounds), and *p*-toluidine.

The authors wish to reserve for a time the study of this new reaction.

115. "*A Method for the Determination of the Equilibrium in Aqueous Solutions of Amines, Pseudo-acids and Bases, and Lactones.*" By TOM SIDNEY MOORE.

The compounds mentioned in the title resemble each other in that their aqueous solutions contain, in addition to ions, two non-ionised forms. The relations may be represented by the equations:—

For a pseudo-acid— $$H\cdot X{:}O \underset{(1)}{\rightleftarrows} X\cdot OH \underset{(2)}{\rightleftarrows} XO' + H\cdot.$$

For an amine— $$NX_3 + H_2O \underset{(1)}{\rightleftarrows} NX_3H\cdot OH \underset{(2)}{\rightleftarrows} NX_3H\cdot + OH'.$$

The reaction constants of the reactions (1) and (2) cannot in general be determined directly, although their determination is a matter of considerable importance; for the constant of reaction (2) is the true ionisation constant of the acid or base; and the constant of reaction (1) represents the relation between the two forms of the pseudo-acid, or between the amine and its hydroxide as the case may be.

The author showed that these constants, as well as their temperature coefficients, may be calculated from the results of measurements of the partition of the substance between water and another solvent, and of the "apparent" ionisation constant (as calculated from the electrical conductivity, or from degree of hydrolysis of salts) at different temperatures.

116. "*The 'True' Ionisation Constants, and the Hydration Constants of Piperidine, Ammonia, and Triethylamine.*" By TOM SIDNEY MOORE.

The equations developed in the preceding paper were applied to the results of the partition experiments of Hantzsch and Sebaldt, Hantzsch and Vagt, and of Dawson and McCrae, and the values of the true ionisation constants (k_1) and of the hydration constants (k_2) determined for different temperatures.

$k_2 C_{NX_3} = C_{NX_3HOH}$ and $k_1 C_{NX_3HOH} = C_{NX_3H^+} \times C_{OH^-}$.

At 20° the results were:—

	$k_1 \times 100$.	k_2.
Piperidine	0·156	2·83
Ammonia	0·0052	0·56
Triethylamine	0·064	1·86

Further, the heat of neutralisation of the three bases and the heat of solution of ammonia were calculated and found to agree satisfactorily with the experimental value.

PHYSICAL SOCIETY.

Ordinary Meeting, May 24th, 1907.

Prof. J. PERRY, F.R.S., President, in the Chair.

A PAPER on "*The Measurement of Mutual Inductance by the aid of a Vibration Galvanometer*," was read by Mr. A. CAMPBELL.

The measurement of mutual inductance is of importance not only in electrical science but also in electrotechnics; for example, it forms the basis of the magnetic testing of iron by the ballistic method. Carey Foster's method of comparing a mutual inductance with a capacity is one of the most convenient methods, and the formula is very simple, being $M = KRr$, where K is the capacity (in farads) and R and r are resistances. The great advantage gained by the use of a *vibration galvanometer* in methods for measuring capacity or inductance (*e.g.* Wien's methods and Anderson's as used by Rosa and Grover) led the author to apply it to the Carey Foster and the Hughes-Rayleigh methods. He found, however, that with alternating currents it was necessary to modify the Carey Foster method by adding a series resistance in the condenser branch; this left the formula $M = KRr$ unaltered and gave an additional formula involving the ratio of a mutual and a self inductance. It turned out that this modification had been suggested by Rowland. The modified method is extremely convenient, the two adjustments required for a balance being independent and the result not involving a knowledge of the frequency; the use of the vibration galvanometer is a great improvement, making the method independent of the wave-form of the current used. The author next discussed vibration galvanometers. They belong to the class of tuned (or resonance) instruments, the use of which in such measurements is due to Max Wien, whose work on the subject, beginning with his tuned optical telephone in 1891, is of the utmost value, and includes many methods which are now standard. If the detecting instrument used in a null method (with alternating current) is adjusted so that its natural period is in tune with that of the applied voltage, it will be set into strong resonance and will be enormously increased in sensitivity for this particular frequency, practically ignoring in comparison all the other components of the wave-form. Thus in any method in which the tuned instrument is used, a sine wave-form may be assumed. Rubens brought out his vibration galvanometer in 1896, the moving part being small soft-iron needles (on a torsion wire) polarised by a pair of magnets with polar windings carrying the current to be measured.

The author exhibited a vibration galvanometer of another type, having a moving coil controlled by an adjustable bifilar suspension. By adjusting the tension of this the tuning is very easily effected. For measuring the frequency to which a tuned instrument is responding, it is convenient to use the Hughes-Rayleigh method, in which a known self-inductance is compared with an unknown mutual inductance, the balance being dependent on the frequency. The author showed such an arrangement in which the slide-wire was graduated directly in frequency (~ per sec.). With accurately known frequency, on the other hand, the method gives absolute values of L and M.

In conclusion the author gave results of tests (by several methods) of a standard mutual inductance of 0·05 henry. The Kirchhoff method with direct deflection on a ballistic

galvanometer (of measured time of swing) gave a mean of 0·05014 henry, while the Carey Foster method gave 0·05009 henry; the probable error of the latter was much smaller than that of the older method.

Mr. A. Russell thanked the author for his most interesting and instructive demonstration. He considered that the bifilar method of suspending the vibrating coil was a great improvement on the single wire method described by Wien in the *Annalen der Physik* in 1901. In the *Physical Review* of last December Mr. Wells states that an alteration of 0·3 per cent in the length (about 12 cm.) of the stretched wire of a vibration galvanometer, when tuned, diminished the amplitude of the oscillation to less than one-fifteenth of its former value. The resonance point is very sharply defined. Hence to work such an instrument at its greatest sensibility, it must be most accurately tuned and it must be supplied with a current of almost absolutely constant frequency. When used to measure currents, the shape of the wave must be known. Mr. Campbell, however, apparently uses his vibration galvanometer mainly in null methods, and so any kind of interrupted or alternating current can be used, the shape of the wave being almost immaterial. He noticed that Mr. Campbell obtained his balance very rapidly by adjusting both the tension of the suspending spring of his galvanometer and, by means of a simple interrupting device, the frequency of the supplied current during the course of the same experiment. The suggested method of measuring frequency was extremely ingenious. He asked whether Mr. Campbell had found it necessary to take into account the "effective internal resistance" of the condensers he used in his tests.

Dr. Eccles asked the author for information as to the differences in performance between vibration galvanometers like the one shown, which employed rotational vibrations, and string galvanometers such as that of Einthoven, where the vibrations are transverse. The latter is a tuned instrument, and, it has been stated, has been used in the measurement of inductance, with what method and degree of success Mr. Campbell might know.

Mr. Rollo Appleyard said the author's methods should be applicable to the case of an inductance shunted by a capacity. In that event it would be useful for measurements of the inductance of telephone cables. If it could be adapted to that purpose, it would be of great service in affording a rapid means of determining the "attenuation constant," when frequency was of importance.

Dr. R. S. Willows said the suspension used by the author was an improvement on those in general use, which were liable to be broken when changing the frequency.

Mr. Campbell, in reply to Mr. Russell, said that the second formula in the modified Carey Foster method involved the resistance in series with the condenser. With a mica condenser it gave results in such close agreement with the first formula, that it precluded the possibility of any apparent resistance in the condenser of the order observed in certain condensers by Rowland and by Mr. Russell. The author was not aware of the use of the Einthoven string galvanometer as a vibration galvanometer, but if the damping could be made small enough there seemed no reason why it should not be so used. In reply to Mr. Appleyard, he thought that one of M. Wein's methods would be applicable.

A "*Note on the Rate of Decay of the Active Deposit from Radium*," by Messrs. W. Wilson and W. Makower, was taken as read.

In some experiments in which the ionisation produced by the α-rays from radium C was balanced against that produced by the more penetrating β- and γ-rays, it was found that after a short time these two ionisations were no longer exactly equal, however carefully they had been adjusted to equality at first. A similar effect had been noticed by Brousson, and was attributed to the slowly-moving β-rays emitted by radium B which is present with the radium C. Since these rays are emitted by radium B, whereas the α and more penetrating β-rays are emitted by radium C, it is to be expected that the rate of decay as measured by these two types of radiation will be different. The authors' experiments test this point, and confirm the view that the observed difference in the rate of decay as measured in the two vessels is due to the slowly-moving β-rays emitted by radium B.

Mr. S. G. Brown exhibited Apparatus for Relay Working of long Submarine Telegraph Cables. (In the absence of Mr. Brown the apparatus was described by Mr. A. E. Powell.)

In dealing with the question of the design of a relay for long cable work conditions and difficulties differing from long-distance telegraphy on land-lines are met with. Firstly, the minute currents recorded at the end of a long cable, when worked at its limit of speed, necessitate an instrument of high sensitiveness. Secondly, there is the difficulty of making and breaking contact with the usual form of "Butt" contact owing to insufficient pressure to break through surface oxidation, or if contact be satisfactorily made, the want of power to break away again due to coherence of the contact surfaces. Thirdly, the variation from the neutral position of a relay-tongue fixed to the coil of a receiving instrument due to the unequal charging up of the cable and receiving condensers necessitates some method of straightening out the zero. Mr. Brown's relay system therefore consists of three parts:—(1) The actual relaying device or "drum relay"; (2) an inductive shunt with closed iron circuit for use across the receiving coil to curb the signals and straighten out the zero; and (3) a method of applying a local current possessing suitable time-lag to the receiving coil to correct the tendency of signals made up of two or more impulses of the same polarity to fall away to zero due to the charging-up of the receiving condenser itself. The action of the drum relay and the details of the apparatus were described, and the running intruments were exhibited after the meeting.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 20, May 21, 1907.

Direct Hydrogenation of Diketones.—Paul Sabatier and A. Mailhe.—When diacetyl, $CH_3.CO.CO.CH_3$, an α-dione, is subjected to hydrogenation in presence of reduced nickel at 140—150°, it is totally transformed into nearly equal volumes of 2—3-butanolone and 2—3-butanediol. When a β-dione, such as acetylacetone, is similarly treated, three-quarters of it undergoes the reaction $CH_3.CO.CH_2.CO.CH_3 + H_2 = CH_3.COH + CH_3.CO.CH_3$, the alcohol and aldehyde being then further hydrogenated to form ethyl and isopropyl alcohol. One-quarter of the acetylacetone is hydrogenated normally, $CH_3.CO.CH_2.CO.CH_3 + H_2 = CH_3.CHOH.CH_2.CO.CH_3$. This second reaction tends to become less important as the temperature is raised, so that even at 180° it is diminished. The γ-dione, 2—5-hexanedione, yields the stable anhydride of diallyldihydrate, $CH_3.CHOH.CH_2.CH_2.CHOH.CH_3$, which is probably itself first formed and then dehydrated.

Explosive Mixtures of Air and Ether.—J. Meunier.—The superior limit of the inflammability of ether appears to be approximately 200 mgrms. per litre of air. At the lower limit, 58 or 60 mgrms. to the litre, it burns slowly without any explosion. When 1 or 2 mgrms. only are present the ether will not burn; from 100 to 175 mgrms. the explosion is violent, being at its maximum between 120 and 150 mgrms. From 175 to 200 mgrms. the violence of

the explosion decreases, and above 200 mgrms. the ether acts as an extinguisher upon a lighted match.

Catalytic Dehydration of Alcohols by Amorphous Phosphorus and Phosphates.— J. B. Senderens.—When amorphous phosphorus acts on ethyl alcohol it decomposes it into water and ethylene, the action increasing with the temperature, and a convenient method of preparing olefines can be based upon this fact. As, however, the catalytic power of phosphorus varies with different specimens, it is better to use the phosphates, aluminium phosphate being specially active. The alcohols of the cyclic series can also be dehydrated by this method, which can be applied to other organic compounds. Moreover, the silicates or silica can be substituted for the phosphates, and silica acts as a dehydrogenating or dehydrating catalyser, according as it is used in the crystalline or amorphous state.

Action of Magnesium Amalgam on Aldehydes.—André Kling and Paul Roy.—When magnesium amalgam acts on ethyl aldehyde a violent reaction occurs, and it is necessary to dilute the aldehyde with benzene and cool the vessel in which the operation is carried out. The author used benzene as a solvent, and poured the product of the reaction into cold water containing a little sulphuric acid, separated off the benzene layer and distilled it. The aqueous solution was neutralised with potassium carbonate, evaporated to dryness at 40°, taken up with chloroform, and re-distilled. It was then found that the product of the reaction is the glycol of aldol. With propyl alcohol the reaction is less energetic, the product being 2-methyl-1 . 3-pentanediol. Apparently the aldehyde and magnesium first form the compound $CH_3—C\begin{matrix}O—Mg\\CH_2\\H\end{matrix}>C<\begin{matrix}H\\OH,\end{matrix}$ which decomposes with water, thus:—

$$CH_3—C\begin{matrix}O—Mg\\CH_2\\H\end{matrix}>C<\begin{matrix}H\\OH\end{matrix}+2H_2O=$$

$$=CH_3C\begin{matrix}OH\\CH_2—C\\H\end{matrix}\begin{matrix}H\\H\\OH\end{matrix}+Mg(OH)_2.$$

Double Compounds of Aluminium Sesquisulphide with Monosulphides of Chromium, Nickel, Cobalt, and Magnesium.—Marcel Houdard.—When a mixture of aluminium and chromium is heated in sulphuretted hydrogen a blackish red crystalline residue is obtained, the analysis of which shows that it consists of $Al_2S_3.CrS$. When nickel and aluminium (in the proportion Al_2 : Ni) are fused together in sulphuretted hydrogen, a well crystallised black mass is obtained, which gives with water red crystals turning black. No definite compound could be isolated. Cobalt behaves similarly. With magnesium and aluminium a compound is obtained, $Al_2S_3.MgS$, corresponding to spinelle, $Al_2O_5.MgO$.

Dissociation of Lithium Silicates.—Edgard Derome.—When lithium silicate is dissociated in an exhausted porcelain tube in an electric furnace it is found that the rate of dissociation decreases very slowly at first, diminishing rapidly when the limit $SiO_2.2Li_2O$ is reached. In another series of experiments the pure crystalline $SiO_2.Li_2O$ was prepared by heating to a red heat for six hours in an open crucible a mixture of 5 SiO_2 and 2 Li_2O in suspension in fused lithium chloride. The rate of dissociation of this silicate continually decreases, the decrease becoming very rapid as $5SiO_2.Li_2O$ is approached, and apparently this last silicate is very little dissociated at 1300°; the micro-chemical examination of the residue showed that it consisted of lamellæ of $5SiO_2.Li_2O$. Probably this silicate also would dissociate if it were heated long enough.

Paraoxybenzoate of Calcium.—Œchsner de Coninck.—At 15° with a small quantity of water calcium paraoxybenzoate forms a crystalline monohydrate. When excess of water at 18° is added the salt begins to dissolve, and solution may be hastened by stirring with a glass rod, the last particles which dissolve showing the phenomenon of triboluminescence. Clear aqueous dilute solutions of calcium paraoxybenzoate deposit on standing a light downy mass, like a flocculent precipitate. This is totally insoluble, and consists of a mixture of several hydrates, the trihydrate predominating among them. The specific gravity of an aqueous solution increases with the concentration. Anhydrous calcium paraoxybenzoate combines with pure methyl alcohol, but not with ethyl alcohol.

Products of Condensation of Ethyl Oxalate with Dimethylaniline in presence of Aluminium Chloride.—A. Guyot.—The first product of the reaction between ethyl oxalate and dimethylaniline in presence of aluminium chloride is ethyl *p*-dimethylamidophenylglyoxalate, $(CH_3)_2N—C_6H_4—CO—CO_2C_2H_5$, the yield being about 60 per cent of the theory. The secondary product is ethyl tetramethyldiamidodiphenylglycolate,—

$$[(CH_3)_2N—C_6H_4]_2COH.CO_2C_2H_5.$$

This substance dissolves in acetic acid, giving an indigo-blue coloration, and condenses with tertiary aromatic amines in aqueous solution, either neutral or acid, giving derivatives of triphenylmethane, according to the equation

$$\begin{matrix}(CH_3)_2N—C_6H_4\\(CH_3)_2N—C_6H_4\end{matrix}>C<\begin{matrix}OH\\CO_2C_2H_5\end{matrix}+R_2N—C_6H_5=$$

$$=\begin{matrix}(CH_3)_2N—C_6H_4\\(CH_3)_2N—C_6H_4\\R_2N—C_6H_4\end{matrix}>C—CO_2C_2H_5.$$

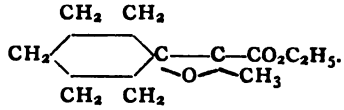
In concentrated sulphuric acid it forms a yellow solution, which, when heated to 140°, gives up carbon monoxide, and yields tetramethyldiamidobenzophenone,—

$$\begin{matrix}(CH_3)_2N—C_6H_4\\(CH_3)_2N—C_6H_4\end{matrix}>C<\begin{matrix}OH\\COOH\end{matrix}=$$

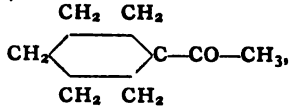
$$=CO+H_2O+\begin{matrix}(CH_3)_2N—C_6H_4\\(CH_3)_2N—C_6H_4\end{matrix}>CO.$$

The ultimate product of the condensation of ethyl oxalate with dimethylaniline is ethyl hexamethyltriamidotriphenyl acetate, $[(CH_3)_2N.C_6H_4]_3C—CO_2C_2H_5$. This compound is also formed—(1) when ethyl dimethylamidophenylglyoxalate condenses with dimethylaniline in presence of phosphorus oxychloride or aluminium chloride; (2) when ethyl tetramethyldiamidodiphenylglycolate condenses with dimethylaniline at 100° in hydrochloric or acetic acid; (3) when ethyl tetramethyldiamidodiphenylamido acetate condenses with dimethylaniline at 100° in hydrochloric or acetic acid; (4) when ethylglyoxyl condenses with dimethylaniline at 100° in absence of any chlorinating agent, the principal product of the reaction being ethyldimethylamidophenylglyoxalate.

Synthesis of Hexahydroaromatic Ketones.—G. Darzens.—Cyclohexanone condenses with ethyl α-chloropropionate, giving a tri-substituted glycide ether, the properties and composition of which indicate that it is—



It saponifies very easily, and the corresponding acid decomposes when distilled *in vacuo*, giving hexahydroacetophenone,—



which boils at 74—76° under 18 mm. pressure. Orthomethylcyclohexanone under the same conditions yields a glycide ether, which, when distilled *in vacuo*, decomposes into carbon dioxide and orthomethylhexahydroacetophenone, which boils at 77—80° under 18 mm. pressure. Paramethylcyclohexanone and the meta-compound also yield glycide ethers, but more complicated ketones, such as

menthone and pulegone, do not form the corresponding compounds.

Metallic Thiocarbamates. Preparation of Thiocarbamides of the Fatty Series.—Marcel Delépine.—When soda and carbon disulphide act upon an amine in aqueous solution and dibasic lead acetate is added, the following reactions occur :—

$$RNH_2 + CS_2 + NaOH = RNH.CS_2.Na + H_2O,$$

$$RNH.CS_2.Na + HO.Pb.CO_2CH_3 = RN:CS + H_2O + PbS + CH_3.CO_2.Na.$$

The solutions when evaporated give crystalline salts which suffer double decomposition with metallic salts. Many of these salts decompose with water, giving thiocarbamide. With secondary amines, sodium salts of the constitution R_2 or RR'N.CS.SNa can be prepared by the same method. These latter also undergo double decomposition with metallic salts. Experiments with dimethyl piperidyl and diisobutyl thiocarbamates of sodium show that the insolubility in water and solubility in organic solvents increase with the molecular complexity of the secondary amine. Salts of amines can be substituted for free amines in this reaction.

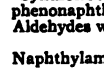
MISCELLANEOUS.

British Association for the Advancement of Science.—The Council has nominated Mr. Francis Darwin, F.R.S., Foreign Secretary to the Royal Society, and author of the "Life and Letters of Charles Darwin," to be Presidenr of the meeting next year, when for the fourth time in its history the Association will assemble in Dublin. The arrangements for the meeting at Leicester, which will open at the end of next month, under the Presidency of Sir David Gill, K.C.B., F.R.S., formerly Astronomer Royal at the Cape, are now well advanced. A generous measure of local hospitality has been provided, and among other social functions there will be given by the Mayor of Leicester, Alderman Sir Edward Wood, an Evening Fête in the Abbey Park ; by the President and Council of the Leicester Literary and Philosophical Society, a Conversazione in the Museum Buildings ; and by Sir Samuel and Lady Faire, a Garden Party at Glenfield Frith.

MEETINGS FOR THE WEEK.

WEDNESDAY, 19th.—Microscopical, 8. "Eye-pieces for the Microscope," by E. M. Nelson. "The Life-history of the Tiger Beetle, *Cicindela campestris*" (Illustrated by Lantern Slides), by F. Enock.

THURSDAY, 20th.—Chemical, 8.30. "Some Properties of Radium Emanation," by A. T. Cameron and Sir W. Ramsay. "Affinity Constants of Aminosulphonic Acids as Determined by the Aid of Methyl-orange," by V. H. Veley. "Azo-derivatives of 1 : 3-Diphenylbarbituric Acid—Dynamic Isomerism among the Coloured Hydrazones of 1 : 3-Diphenylalloxan," by M. A. Whiteley. "A Series of Coloured Diazo-salts derived from *p*-Amino-aceto-α-naphthalide," by G. T. Morgan and W. O. Wootton. "Colour and Constitution of Azo-compounds," by J. T. Hewitt and H. V. Mitchell. "Oxidation of Hydrazines by Free Oxygen," by F. D. Chattaway. "Calmatambin, a New Glucoside," by F. L. Pyman. "Decomposition of Hyponitrous Acid in presence of Mineral Acids," by P. C. Ray and A. C. Ganguli. "Chemical Composition of Petroleum from Borneo," by H. O. Jones and H. A. Wootton. "Synthesis of Phenonaphthacridines—Trimethylphenonaphthacridines" and "Condensation of Aldehydes with Mixtures of α-Naphthol and α-Naphthylamine—Synthesis of 7-Aryl-



dinaphthacridines," by A. Senier and P. C. Austin. "Improved Form of Apparatus for the Rapid Estimation of Sulphates and Salts of Barium" and "The Determination of Sugar by Fehling's Solution," by W. R. Lang and T. B. Allen.

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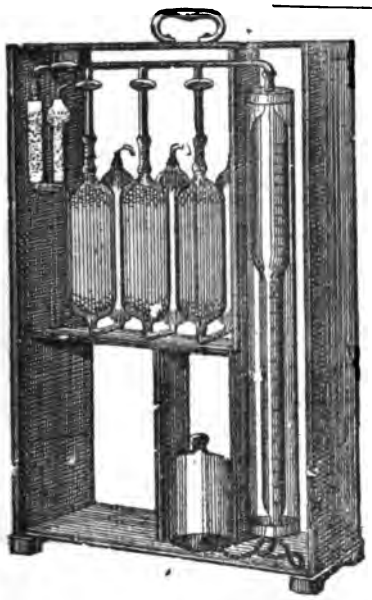

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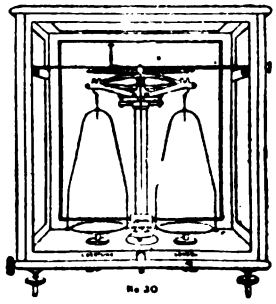

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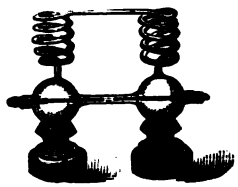

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THE CHEMICAL NEWS.

Vol. XCV., No. 2482.

ON THE THERMO-CHEMISTRY OF FLAME SPECTRA AT HIGH TEMPERATURES.*

By W. N. HARTLEY, F.R.S., D.Sc., Royal College of Science Dublin.

(Concluded from p. 279).

The Alkaline Earths.

It has been shown that these substances are of a different nature, and their salts are sharply divided into two classes, the haloid and the oxy-salts, each with a different behaviour.

The Haloid Salts.—These are volatile in flames supplied with the halogen hydrides without decomposition. They are also volatile without decomposition in a dry carbonic oxide flame. Here, then, we may probably have the spectra of salts and not of the metals. In a hydrogen or coal-gas flame the salts are hydrolysed and converted into oxides by heat; this is a fact well known. If we examine the heat of formation of the chlorides, we find it to be, for calcium and strontium respectively—

$$\xi CaCl_2 = 169{\cdot}9 \text{ K}^\circ \text{ and } \xi SrCl_2 = 184{\cdot}7 \text{ K}^\circ,$$

while the oxides are—

$$\xi CaO = 131{\cdot}5 \text{ K}^\circ \text{ and } \xi SrO = 131{\cdot}2 \text{ K}^\circ.$$

The barium chloride has not been determined, but the oxide is—

$$\xi BaO = 133{\cdot}4 \text{ K}^\circ,$$

(A. Guntz, *Comptes Rendus*, 1903, cxxxvi., 1071), and we may therefore safely say that the energy of formation of the chloride does not differ much from the number deduced from strontium chloride or about 187 K°.

The effect of water-vapour in the flame is an endothermic reaction when the chloride is a solid.

$$\xi(CaCl_2 + H_2O = CaO + 2HCl) = -37{\cdot}5 \text{ K}^\circ;$$
$$\quad\quad\quad

not a very great difference. Substituting gaseous carbon monoxide for solid carbon, we obtain—

$$\underset{393}{\xi(Al_2O_3} + 3CO = 2Al + \underset{68{\cdot}3\times3}{3CO_2}) = -188{\cdot}1 \text{ K°},$$

or, for 1 atom of oxygen removed, ⅓ of this = −62·7 K°.

The actual energy supplied in these reactions before the aluminium can be reduced is for carbon, carbon monoxide, and for hydrogen respectively, −82·5 K°, −62·7 K°, and −72·9 K°. The carbon monoxide value is thus shown to be less than that in either of the other two reactions. It has already been proved, first, that alumina is reduced to the metallic state in the oxyhydrogen flame; secondly, that the reduction takes place more easily when the alumina is mixed with some dense form of carbon. In the first instance, the flame alone supplied hydrogen only as the reducing agent; consequently, the energy required for every atom of oxygen removed was 72·9 K° in the form of extraneous heat which was necessary not only for initiating the process, but also maintaining it. When solid carbon was used, this was a somewhat higher figure, being 82·5 K°, but this very reduction process with solid carbon would result in the formation of carbon monoxide which could then operate upon another molecule of alumina, which places the extreme limits of the energy required for reduction as between 63 K° and 82·5 K°. From this it would appear that *any reducing process may be carried out in the oxyhydrogen flame by a purely chemical action if the extraneous energy required to initiate and maintain the action does not exceed* 84·8 K° *per atom of oxygen to be removed.* (This is the figure for the zinc reduction ξZnO = 84·8 K°, that calculated for alumina is 82·5 K°).

Let us now consider another instance of the reduction of a solid oxide in the flame, namely, beryllia. The energy of formation of the oxide is unknown, but its composition is BeO.

Pollok has measured the heat of formation of the chloride $\xi BeCl_2$ = 155 K°, and of the heat of dissolution of beryllium in aqueous hydrochloric acid $\xi BeCl_2$ = 199·5 K°. Comparing these results with the heat of formation and solution of aluminium chloride, we obtain the following figures:—

	Al_2C_6.	$\frac{1}{2}Al_2Cl_6$.	BeCl.
Heat of formation ..	323·6	107·9	155·0
Heat of solution . ..	152·6	50·9	44·5

Similar comparisons, made with magnesium and zinc chlorides, give:—

	$BeCl_2$.	$MgCl_2$.	$ZnCl_2$.
Heat of formation ..	155·0	151·0	97·4
Heat of solution . ..	44·5	36·0	15·6

These figures show that in each case a fall in the heat of formation and solution accompanies the rise in the atomic weights.

Now—

$$\xi Al_2O_3 = 393 \text{ K°} = \xi\tfrac{1}{2}Al_2O_3 = 131 \text{ K°},$$

and—

$$\xi\tfrac{1}{2}Al_2Cl_3 = 107{\cdot}9 \text{ K°};$$

the difference, 23·1 K°, shows that the energy of formation of the oxide is by that amount greater than the chloride, and as—

$$\tfrac{1}{2}BeCl_2 = 155 \text{ K°},$$

we may assume the value—

$$\xi BeO = 178{\cdot}1 \text{ K°}$$

to be approximately correct. But—

$$\xi MgO = 143{\cdot}4 \text{ K°} \text{ and } \xi ZnO = 84{\cdot}8 \text{ K°},$$

also—

$$\xi MgCl_2 = 151{\cdot}0 \text{ K°} \text{ and } \xi ZnCl_2 = 97{\cdot}4 \text{ K°},$$

the difference between magnesium chloride and oxide is 7·6 K°, and between zinc chloride and oxide 2·6 K°, we may assume then that ξBeO = 148 K°, and this number is very probably more correct than that derived from the figures obtained from a comparison of the difference between the oxide and chloride of aluminium, because magnesium and zinc belong to the same group as beryllium, and aluminium does not.

The metal is certainly reduced from the oxide by the oxyhydrogen flame, and as far as we know beryllia is not a volatile oxide, nor is it fusible. The reduction must therefore be the result of a purely chemical action, and it must also be of a highly endothermic character, as may be seen by the equation following:—

$$\underset{148}{\xi(BeO} + H_2 = Be + \underset{50{\cdot}6}{H_2O}) = -97{\cdot}4 \text{ K°}.$$

Endothermic.

It may be inferred from the evidence afforded by the flame spectra, that at these high temperatures the infusible and non-volatile metallic oxides are in a peculiarly active condition, having absorbed a large amount of energy from the flame, so that they are approaching the condition of dissociation, and are therefore subject to chemical interactions with the reducing gases, which otherwise would have no power to reduce them. But in the cases referred to, the reducing gas is hydrogen, and in all probability it is not the hydrogen supplied to the flame in the molecular condition, but hydrogen in the atomic or nascent state, resulting perhaps from the dissociation of water, the product of combustion in another part of the flame, which carries with it the additional charge of energy which enables it to initiate and complete the reduction process.

Conclusions.

1. The oxides of calcium, strontium, and barium are not dissociated by heat alone, because they show no spectrum in a carbon monoxide flame. 2. They are reduced by the combined action of heat and hydrogen in the oxyhydrogen flame and by the action of cyanogen in the cyanogen flame. 3. The flame coloration is due to the metal, because not only is the flame spectrum from lime essentially the same as that of the metal calcium, but also the heats of formation of CaO, SrO, and BaO have very nearly the same value, and that where calcium oxide can be reduced the other oxides could, on that account, undergo a similar reduction. Whether the compound of strontium or barium in the flame be a sulphide or an oxide, the same spectrum is emitted, but there is some uncertainty as to whether the barium sulphide is not converted into oxide by water-vapour in the flame.

The explanation given by Lenard, of the flame coloration by the alkali salts, appears to be inapplicable to the coloration of the carbon monoxide flame by the haloid salts of the alkaline earth metals.

Spectroscopic Apparatus.—Messrs. Adam Hilger, Ltd., have sent their latest catalogue of "Spectroscopes and Spectroscopic Apparatus." It is evident that great advance has been made in the design and manufacture of these instruments, particularly in those adapted to the production of photographic records. Quartz lenses and prisms are used, the latter being cut on the "Cornu" plan, in two halves, one right and the other left-handed, so as to avoid double refraction. By using Wratten and Wainwright's panchromatic plates with these instruments it is possible to get photographed spectra from λ 2000 down to λ 7000. The value of such apparatus in experimental research is so obvious that the wonder is we have had to wait so long for them. We have seen a print of the copper spectrum made on their smallest quartz instrument and enlarged three and a-half times; the lines are clear and sharp from one end to the other, and testify to the excellence of the workmanship. Messrs. Hilger have also two models of photo-measuring micrometers designed for use with spectrum photographs, together with many other forms of spectroscopic apparatus now coming into general use, including Appleyard's Spectroscope-refractometer, Michelson's Interferometer, and Lummer Gehrcke's Parallel Plate Spectroscope.

INFLUENCE OF SOLVENTS IN THE CLAISEN CONDENSATION.

CATALYTIC ACTION OF ETHER AND OF TERTIARY BASES IN THIS REACTION AND ALSO IN THE FORMATION OF THE GRIGNARD REAGENT.

(PRELIMINARY COMMUNICATION).

By J. BISHOP TINGLE and ERNEST E. GORSLINE.

IN a paper read in abstract before the American Chemical Society, at the New York meeting in December, 1906, we stated that we had obtained evidence which pointed to a specific action on the part of the solvent on the course of the Claisen condensation. We have now accumulated a number of observations bearing on this subject, all of which point to the *complete parallelism of the Claisen and Grignard reactions, so far as the effect of solvent is concerned.* We find that certain reactions, such for example as that between ethyl oxalate and camphor, take place readily and, apparently, with practically equal ease in ligroin or in ether solution. Others, such as that between ethyl phthalate and camphor, require many hours or days in ligroin solution, but take place easily when the materials are dissolved in ether. If a litttle ether be added to the ligroin solution, reaction begins at once and proceeds to completion. Apparently, the time required to carry the reaction to an end is dependent, other things being equal, on the amount of ether added. The position, then, is this, *we can accelerate or retard a given condensation by adding or withholding ether from the solution.*

The question at once arises, is this change in the velocity of the reaction due to a difference in the solvent action of the ether, or ether-ligroin mixture, as compared with the ligroin alone, or is it due to a difference of the temperature at which the reactions were carried out? With regard to the last point we may say that all our ligroin boiled at 36°, so that experiments carried out at its boiling point were practically at the same temperature as those carried out at the boiling point of ether. Actually, however, the majority of the experiments were performed at the temperature of the room. Moreover, we find that, under otherwise similar conditions, the time and temperature factors are inversely proportional, *i.e.*, a reaction which requires days for completion at the ordinary temperature, will be finished in a few hours if the temperature is raised to that of the boiling point of the solvent. The yield of the condensation product is practically the same in the two cases. In all our experiments, unless otherwise stated, we used sodium wire as the condensing agent. It is, perhaps, hardly necessary to add that, before use, all our solvents were treated with sodium wire until they ceased to react with it.

We may now take up the question of the solvent action of ether and ligroin. Camphor and all of the esters we employed dissolve in each solvent with great and, apparently, equal readiness, and the same is true of the condensation products; consequently the difference of solubility, if it exists, must be concerned with the sodium salts formed during the condensation of the ketone and ester. We have paid a good deal of attention to this point and have observed that the substances formed on the sodium wire sometimes flake off as rapidly as they are produced, and become partly suspended and partly dissolved in the liquid; often there is a deposit of this material on the bottom of the flask; frequently, however, it is all, or practically all, in solution. Sometimes the sodium wire becomes thickly incrusted with a hard, rough coating of a salt, which clings to the metal and retains the general shape of the original wire. Contrary to our expectations, the formation of this substance does not materially protect the sodium from being attacked by the reagents, nor does it adversely affect the yield of condensation product. Examination of the incrusted material will show that it often contains a minute thread of metal.

These differences appear to depend upon extremely subtle changes in temperature, speed of reaction, &c., and it is impossible for us to define exactly the conditions necessary for obtaining any given result, though all of them will be observed if a considerable number of condensations is carried out. In some instances, moreover, the sodium salt formed remains incrusted over the wire and retains the wire form when examination shows that all the sodium has disappeared. The interesting point in this connection is that the *yield of condensation product is essentially the same whether the sodium compound dissolves in the liquid, is suspended in it, or forms a crust over the sodium wire.* In order to cast a little additional light on the subject we prepared a concentrated solution of sodium ethylate in alcohol. Equal volumes of ether, ligroin, benzene, and toluene were mixed with separate, equal quantities of this alcoholic solution; in no case was a precipitate or turbidity formed. As is well known, sodium ethylate free from alcohol is practically insoluble in ether or ligroin, but this fact has no direct bearing on our experiments. Having now determined the influence of all the factors which we thought likely to affect the result, and having established, thereby, the specific action of ether as an accelerator of the condensation, we turned our attention to the discovery of other substances which might exert a similar influence. Two of these we found to be pyridine and quinoline, which appear to be about equal in their efficiency. Their influence is quite well defined, though it is not as great as that of ether. We have carried out experiments in ligroin solution, adding a little of each tertiary base, and have also made condensations with pyridine alone as the solvent. The results were similar in all cases. Furthermore, we believe that we have evidence showing that, in the case of condensation compounds capable of existing in both the enolic and the ketonic forms, the use of pyridine or quinoline in the course of their formation leads to a disturbance of the ordinary equilibrium in favour of the production of the ketonic form. This is one of the points which is, at present, under investigation; should it prove to be substantiated we may expect that it will be of considerable importance in the preparation of the class of bodies in question.

One of the theories regarding the course of the Claisen condensation postulates the formation of sodium ethylate as the first step; this is supposed to undergo certain changes, resulting, finally, in the elimination of 2 molecules of alcohol for each molecule of sodium ethylate added. In this manner it has been sought to explain the gradual acceleration of the reaction leading to the production of ethyl acetoacetate. Should this hypothesis be correct it is evident that sodium ethylate itself should be an excellent accelerator. This we have found to be the case. The addition of a few drops of absolute alcohol, saturated with sodium, to a mixture of ligroin, ethyl acetate, and sodium wire immediately starts a reaction. A comparison experiment showed that alcohol itself assisted in promoting the action of the sodium, to an extent even greater than that exhibited by sodium ethylate. In presence of the latter the sodium wire was immediately darkened and the reaction continued steadily to the end. With the absolute alcohol the sodium wire remained entirely unattacked for nearly five minutes; a white compound was then formed in small quantity, and immediately thereafter a darker coloured product. The reaction now proceeded rapidly and was apparently completed much sooner than when sodium ethylate was used. These experiments were carried out with camphor and ethyl phthalate, in ligroin solution. It may be added that in the course of a large number of experiments performed with various esters and condensing agents, we have never obtained a good yield of condensation product if we found it necessary to add alcohol in order to bring the sodium into solution. This is in entire accord with Claisen's experience. He found that sodium ethylate, in alcoholic solution, was the least active

condensing agent. This point is at present under investigation.

In a series of papers of great interest, W. Tschelinzeff (*Ber.*, 1905, xxxvii., 2081, 4534; xxxviii., 3664; *cf.* Tingle, *Amer. Chem. Journ.*, 1906, xxxv., 94) has shown that the Grignard reagent is probably an oxonium derivative, that at all events, as usually prepared, it contains ether as an integral part of the molecule. He has also demonstrated that certain tertiary bases, such as dimethylaniline, can take the place of the ether, and, further, that although, in the absence of ether or of a tertiary base, the formation of the Grignard reagent does not take place at the temperature of boiling ether, yet it does so if the temperature be sufficiently raised, say to that of boiling benzene or toluene. He points out that both the ether and tertiary base act as typical catalytic agents in this reaction, and give the formulæ—

$$(C_2H_5)_2O\!<\!{}^{MgR}_{X} \quad \text{and} \quad C_6H_5N(CH_3)_2\!<\!{}^{X}_{MgR}$$

as representing the probable constitution of the MgR ether compound and that of the tertiary base, respectively. It is at once evident that there is a close analogy between our results with the Claisen reaction and those of Tschelinzeff with the Grignard reagent. Accordingly, we have carried out a number of experiments to clear up certain points regarding which information was not available.

Our conclusions may be briefly summarised as follows :—The rapidity with which the magnesium is attacked by the halide compound is dependent on the nature of the alkyl or aryl halide employed, provided, of course, that other conditions remain constant. The presence of ether is not essential to the reaction, *neither is a high temperature necessary, provided that sufficient time be allowed.* A number of our experiments were carried out at the ordinary room temperature, in ligroin solution (b. p. 36°). The Grignard reaction admits of being controlled with the greatest ease; as is well known, its velocity can be increased by the use of ether, a tertiary base (pyridine, quinoline, &c.), or iodine, or by means of a high temperature (see above). The use of low-boiling ligroin, on the other hand, quickly diminishes the speed of reaction. In short, then, we appear to have a *complete analogy in behaviour between the Claisen reaction and the formation of the Grignard reagent.*

As regards the theory of the latter, we should like to offer a few remarks which will follow the same general lines as the ideas of Tschelinzeff, although there are one or two points which we think are not made quite clear in his paper. The reaction $Mg+RX \rightarrow Mg\!<\!{}^{R}_{X}$ takes place with more or less difficulty, depending on the factors referred to above. Grignard's reagent has the formula $Mg\!<\!{}^{R}_{X}$, *i.e.*, ether is *not* an essential constituent. The reaction represented above is greatly accelerated by the presence of a little ether, which acts as a catalyst, forming an oxonium compound, such as $(C_2H_5)_2O\!<\!{}^{MgR}_{X}$ (Tschelinzeff). Evidently, however, this is *not* the compound which *necessarily* reacts with the aldehyde, ester, &c., in the Grignard condensations; although, of course, in presence of excess of ether it might be capable of doing so, it must therefore be an intermediate compound, in equilibrium, as represented by the equation—

$$Mg+RX+(C_2H_5)_2O \rightleftarrows (C_2H_5)_2O\!<\!{}^{MgR}_{X} \rightleftarrows (C_2H_5)_2O+Mg\!<\!{}^{R}_{X}.$$

The question now arises—To what is the acceleration of the ether due? As it is difficult to see how it can have any effect on the magnesium metal, we can only regard it as favouring the dissociation of the alkyl halide into R+X, and since the question is not one of dilution, we see no escape from the conclusion that it forms the oxonium compound, $(C_2H_5)_2O\!<\!{}^{R}_{X}$, which would certainly be unstable, and would therefore in all probability unite quickly with the magnesium to form $Mg\!<\!{}^{R}_{X}$. In support of this theory of ours we may point out that the corresponding reaction with a tertiary base, leading—in the case of dimethylaniline—to the production of the compound—

$$C_6H_5N(CH_3)_2\!<\!{}^{R}_{X}$$

is exactly what we expect from such substances, whereas, to say the least, a compound—

$$C_6H_5N(CH_3)_2\!<\!{}^{MgR}_{X},$$

as formulated by Tschelinzeff, is very unusual, and without any special analogy. A further point for consideration is the effect of the trace of iodine which is so frequently added to start the attack on the magnesium. In view of the work of Baeyer and Villiger (*Ber.*, 1903, xxxvi., 2775; *cf.* Tingle, *Am. Chem. Journ.*, 1906, xxxv., 95), it can hardly be doubted that a magnesium subiodide, such as MgI_2, is first produced, and that this then reacts with the oxonium compound formulated above. Of course the magnesium is often attacked directly by the halide compound; to what extent this occurs obviously depends on the nature of the latter. To sum up, then, we regard the acceleration in the formation of the Grignard reagent as dependent on such actions as are represented by the equations :—

1. $Mg_2+I_2 \rightarrow IMg.MgI.$
2. $RX+(C_2H_5)_2O \rightleftarrows (C_2H_5)_2O\!<\!{}^{R}_{X}.$
3. $(C_2H_5)_2O\!<\!{}^{R+MgI}_{X} + (C_2H_5)_2O\!<\!{}^{X}_{MgI} \rightarrow 2(C_2H_5)_2O+X_2+2RMgI.$

Almost ever since the discovery of ethyl acetoacetate the mechanism of its formation has been a matter of controversy. The investigation of the Claisen condensation, of which the reaction in question is a special case, so far from settling the matter, appeared to rouse the combatants to greater efforts and more vigorous language. During the past ten years the dispute has been carried on chiefly by Claisen, Michael, and Nef, each of whom had a particular theory to support. Quite recently Professor Nef (*Amer. Chem. Journ.*, 1907, xxxvii., 302) has announced that he has abandoned his own theory in favour of that of Claisen. It is but just to say that he is, apparently, at present, at least as emphatically in favour of Claisen's theory as, heretofore, he has been against it, and that now he appears to be just as certain that Claisen is right and Michael is wrong as, in the past, he has been prepared to demonstrate, beyond question, that they were both absolutely in error. To us, and we believe to most chemists, the only thing about the matter which is beyond dispute is that when three investigators of the eminence of Messrs. Claisen, Michael, and Nef disagree on a question, it may be taken

as certain that the experimental data are necessarily inadequate to support any theory.

It would be easy for us to put forward a more or less attractive looking scheme of equations which could be made to include many fanciful dissociations and be in accord with our own work; we have not done so because we believe that such an attempt is premature in the present state of knowledge of the subject. Nevertheless, we desire to emphasise the fact that any hypothesis which may be put forward in the future will have to take account of the *accelerating action of ether and of the tertiary bases, and also of the similarity between the Claisen reaction and the formation of the Grignard reagent.*

Experimental.

The following experiments were carried out with camphor (1·5 mol.), unless otherwise stated. The proportion of sodium wire was 1 atom and of the particular ester 1 molecule.

1. No apparent action takes place on adding camphor, dissolved in ethyl benzoate, to sodium dissolved in absolute alcohol (4 mol.). After remaining for some hours the mixture was heated on the water-bath for two hours. A light colored precipitate formed which gradually settled as a dark cake on the bottom of the vessel. Treatment with ice water followed by acidification gave unchanged ethyl benzoate. No condensation compound could be detected. This experiment shows how *slight* is the *condensing power of sodium ethylate;* the following two demonstrate the *effect of temperature.*

2. Ethyl benzoate and camphor, with sodium wire and ligroin (b. p. 36°), were mixed at the ordinary room temperature. After forty-eight hours, without heating, the sodium had almost entirely disappeared. In another experiment the time required was five working days.

3. In this experiment the mixture was heated on the water-bath to the boiling point of the solvent. After two hours action appeared to be complete, but the mixture was allowed to remain over night. The yield was practically the same as in 2.

Experiment 4 proves the effect of *differences in the ester.*

4. Ethyl oxalate, under conditions given in 2, reacts vigorously in a few minutes, without external heat. The yield was essentially the same as usual (*vide* Bishop Tingle; *Amer. Chem. Journ.* 1897., xix, 393; 1898, xx., 218).

The result of differences in the *constitution of the ketone or aldehyde* employed is sufficiently evident from Claisen's work, so that we paid no particular attention to this point.

Our next experiments were directed to prove that *the solvent* exercises a *decided effect on the progress of the reaction.*

5. Experiment 2 was repeated, except that to the 400 cc. of ligroin 100 cc. of absolute ether were added. The wire quickly darkened and became rough, and a dark mass collected at the bottom of the vessel. At the end of three hours, without heating, the action was complete and an excellent yield of condensation product was obtained. This, taken in conjunction with the second experiment, not only proves the question of acceleration, but also shows that the action is *not due* to *increased solubility* of any sodium salt in the ether-ligroin mixture, as compared with ligroin alone.

Experiments 6 and 7 demonstrate the result of the addition of *pyridine* and *quinoline*, respectively, in place of ether.

6. The conditions were similar to Expt. 5, but 75 cc. of pyridine were added in place of the ether. The liquid rapidly darkened and behaved essentially as in the previous case. The reaction appeared to be complete in about twelve hours. The yield was poor.

7. In this case the pyridine was substituted by 20 cc. of quinoline. Action commenced at once, the liquid depositing a dark brown substance in the usual manner. The mixture was heated to boiling for two hours, at the end of which time the action was finished. The yield was good.

The influence of *sodium ethylate* or of *absolute alcohol, in small quantity*, is shown by Expts. 8 and 9.

8. Experiment 7 was repeated, but in place of the quinoline there was added 50 cc. of absolute alcohol saturated with sodium ethylate, *i.e.* treated, with the metal until the latter remained undissolved. The liquid darkened at once, the wire became coated, and after ten minutes the contents of the flask began to boil quietly. After thirty minutes the wire had completely disintegrated. The yield of condensation product was very poor, but a relatively large quantity of benzoic acid was obtained.

9. This was essentially the same as Expt. 8, except that for the sodium ethylate solution there was substituted an equal volume of absolute alcohol. The action was complete in fifteen minutes, and, as in the previous case, a red mass settled to the bottom of the vessel.

We have carried out experiments with camphor and ethyl phthalate similar to Expts. 2, 5, 7, 8, and 9 recorded above for ethyl benzoate. In general, the results were entirely analogous; the chief difference is that ethyl phthalate reacts rather more readily than ethyl benzoate. In a further experiment we tried the effect of adding 2 drops of sodium ethylate solution, as above, to the substances dissolved in 200 cc. of ligroin. The reaction was, of course, not so rapid as in those experiments where a larger quantity was added, but its accelerating action was more marked than that of 10 cc. of quinoline or or 25 cc. of ether, under similar conditions. The yield was, however, *markedly less*, only about half of that obtained by the use of ether or of quinoline, or when no accelerator is employed.

We have also studied the condensation of ethyl acetate to ethyl acetoacetate. By dissolving the ester (17·6 grms.) in ligroin (b. p. 36°, 200 cc.) and adding the sodium wire, the reaction proceeds very slowly and was not completed after six hours' boiling; indeed, some wire remained undissolved after five days' subsequent standing, at the ordinary temperature. In contrast with this the addition of 75 cc. of ether caused the disappearance of the sodium after two hours' heating. Pyridine (50 cc.) acted in almost exactly the same way. The use of 5 drops of sodium ethylate solution once more demonstrated how rapidly this substance stimulates a reaction. After 0·5 hour at the ordinary temperature and one hour's heating, the sodium had nearly all dissolved. The ethyl acetoacetate was separated and identified in the usual manner, by the ferric chloride test and by fractionation under reduced pressure.

Experiments on Grignard's Reaction.

Ethyl chloracetate, in ethereal solution, reacts very vigorously with magnesium. In ligroin (b. p. 36°) solution, on the other hand, no change was apparent after three hours' boiling. The addition of a fragment of iodine, followed by boiling for ten hours, caused the production of a quantity of light yellow material. The experiment was repeated, 10 cc. of ether being used in addition to the ligroin. There was no change after three hours' boiling, but when a fragment of iodine was added a rather vigorous action began, the light yellow solid collecting in fairly considerable quantity. This demonstrates the *formation of Grignard's reaction at* 36°.

Experiments were now carried out with ethyl iodide (7·8 grms.), magnesium (1·22 grms.), ligroin (500 cc.) and quinoline (30 cc.). There was no evident action on standing at the ordinary room temperature, but the magnesium was almost completely dissolved after boiling during twenty minutes. The experiment was repeated, ether (25 cc.) being substituted for the quinoline. In this case the reaction began vigorously in the cold and the liquid soon commenced to boil.

Further experiments were carried out with pyridine in

the place of quinoline, the results being essentially similar to those described above.

Our work is being continued in several directions and we hope to communicate further results, together with fuller experimental details, in a subsequent paper.—*American Chemical Journal*, xxxvii., No. 5.

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

PART II.—ANALYSIS OF THE SILVER, COPPER, AND TIN GROUPS.

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Continued from p. 282).

CONFIRMATORY EXPERIMENTS AND REFERENCES (*contd.*).

Analysis of the Copper Group.

P. 23, N. 1: *Solubility of the Copper Group Sulphides in* HNO_3.—500 mgrms. of Pb, Bi, Cu, and Cd as sulphides were treated in separate experiments according to P. 23; the sulphides dissolved almost completely when the solution began to boil, but the sulphur residue remained dark coloured (except in the case of cadmium) even after several minutes' boiling.

500 mgrms. Pb, Bi, Cu, and Cd as sulphides were in separate experiments boiled in an open casserole with about 30 cc. of a mixture of one volume HNO_3 (1·20) and three volumes of water; Bi_2S_3 and CuS dissolved in five minutes or less, PbS dissolved less readily, and CdS only after ten to fifteen minutes. The experiment was repeated, except that 50 cc. of a still more dilute acid was used; the result was the same, except that solution took place somewhat less rapidly.

500 mgrms. Hg as HgS were treated according to P. 23; and the filtrate was evaporated with excess of HCl to a small volume, diluted, and saturated with H_2S; a precipitate of HgS estimated to contain less than 1 mgrm. Hg resulted. The experiment was repeated, except that 30 cc. HNO_3 (1·20) were used, and the boiling continued for ten minutes; a precipitate of HgS estimated to contain 2 mgrms. Hg resulted. The experiment was repeated, except that 30 cc. of a mixture of one volume of HNO_3 (1·20) and three volumes of water were used, and the boiling continued for ten minutes; a precipitate of HgS containing about 0·5 mgrm. Hg was formed. One mgrm. Hg as HgS was boiled with HNO_3 (1·20) for ten minutes; no change in the amount of the sulphide was apparent.

P. 23, N. 4: *Action of Strong* HNO_3 *on* HgS.—500 mgrms. Hg as HgS were boiled for ten minutes with 30 cc. HNO_3 (1·42); the black precipitate had then become pure white. The filtrate was freed from HNO_3 and saturated with H_2S; a precipitate containing several mgrms. Hg was formed. The experiment was repeated, replacing the HNO_3 (1·42) by the strength used in P. 23; no change in the appearence of the precipitate took place.

P. 23, N. 5: *Action of Dilute* HNO_3 *on* Au *and* PtS_2.—That small quantities of gold and platinum are not dissolved in P. 23 is shown by the results of Test Analyses, Nos. 106 to 113.

P. 23, N. 6: *Oxidation of* PbS *to* $PbSO_4$.—500 mgrms. Pb as freshly precipitated PbS were treated according to P. 23, and to the filtrate $BaCl_2$ was added in large quantity; a precipitate of $BaSO_4$ estimated to correspond to 20 to 30 mgrms. Pb was formed. The experiment was repeated, except that the sulphide was boiled for ten minutes with a more dilute acid, containing one volume HNO_3 (1·20) and three volumes water; the result was the same. The experiment was repeated, except that HNO_3 (1·20) was used, and the mixture boiled for ten minutes; there was left with the sulphur a small white residue of $PbSO_4$, estimated to contain 5 mgrms. Pb, showing that the amount of H_2SO_4 formed increases with the HNO_3 concentration.

Solubility of $PbSO_4$ *in Dilute* HNO_3.—To 50 and 100 mgrms. Pb as $PbSO_4$ in separate experiments 30 cc. of a mixture of one volume HNO_3 (1·20), and three volumes of water were added, and the mixtures heated; the 50 mgrms. dissolved in the cold, the 100 mgrms. upon boiling.

P. 23, N. 7: *Action of* HNO_3 *on* SnS, SnS_2, *and* Sb_2S_3.—Ten mgrms. Sn as SnS and 10 mgrms. Sn as SnS_2 were in separate experiments treated by P. 23; there was a white residue in each case. The filtrate was evaporated with H_2SO_4 to slight fuming, diluted, and saturated with H_2S; a yellow precipitate of SnS_2 estimated to contain 0·5 mgrm. Sn was formed.

Ten mgrms. Sb as freshly precipitated Sb_2S_3 were treated by P. 23; the orange colour of the sulphides disappeared at once, and a small white precipitate separated, which was estimated to contain 3 to 4 mgrms. Sb. The experiment was repeated with 5 mgrms. Sb; no white residue was left. The filtrates in these two experiments were made alkaline with NH_4OH; no precipitate of antimony hydroxide separated, even on standing.

P. 24, N. 1: *Behaviour of* HgS, PtS_2, Au, *and Metastannic Acid towards Bromine Solution.*—100 mgrms. Hg and 500 mgrms. Hg as precipitated HgS were warmed slightly in a covered casserole with 30 to 40 cc. saturated Br_2 solution; the 100 mgrms. dissolved completely, and about three-fourths of the 500 mgrms. dissolved. The latter was treated with another portion of bromine water; the residue became nearly white, but blackened slightly when treated with ammonium sulphide.

The experiment was repeated with 10 mgrms. Sn as metastannic acid, obtained by treating SnS with dilute HNO_3 by P. 23, the solution was boiled, filtered, and saturated with H_2S; scarcely any precipitate of SnS_2 was formed. That even small quantities of Au and PtS_2 dissolve in bromine solution is shown by the results of Test Analyses, Nos. 106 to 113.

P. 24, N. 2: *Reduction of* $HgCl_2$ *by* $SnCl_2$.—To 1 mgrm. Hg as $HgCl_2$ in 20 cc. water one drop $SnCl_2$ solution (1 per cent Sn) was added; a nearly white precipitate formed at once. One or two drops more $SnCl_2$ were added; the precipitate darkened rapidly. The experiment was repeated, except that 0·3 to 0·5 cc. HCl (1·12) was added to the $HgCl_2$ solution before the $SnCl_2$; a precipitate formed, which remained white for some minutes, even after the addition of several drops of $SnCl_2$ solution.

P. 24, N. 3: *Oxidation of Mercurous Salts by* HNO_3.—See Part I., C. E., P. 3, N. 7.

P. 24, N. 4: *Colour of Dilute Solutions of Gold and Platinum.*—One mgrm. Au as $AuCl_3$ and 1 mgrm. Pt as H_2PtCl_6 were added in separate experiments to 20 cc. water, and boiled; the solutions had a very pale yellow colour, but this colour was distinct. A few drops of bromine water were added, and the solutions were boiled to expel the bromine; the yellow colour was more distinct than before.

*P. 24*a*, N. 1: *Detection of Gold, Platinum, and Mercury in the presence of each Other.*—Mixtures of elements as shown below dissolved in a little dilute HCl were treated by *P. 24*a*, and the tests, recorded as in the Test Analyses, resulted as follows:—

Pt	0—	0—	1 S	50 S
Au	10 S	1 S	1 S	0—
Hg	1 S	200 S	200—	1 S

P. 25, N. 1: *Separation of Metastannic Acid from* HgS.—See Test Analyses, Nos. 10 to 20.

P. 26, N. 1: *Solubility of* $PbSO_4$ *in Water and* H_2SO_4.—According to Böttger (*Zeit. Phys. Chem.*, 1903, xlvi., 604), 10 cc. of the saturated solution in water at 25° contain about 0·3 mgrm. Pb. For its solubility in concentrated H_2SO_4 of different strengths, see Comey, "Dictionary of Solubilities," p. 436.

To determine at what concentration of H_2SO_4 the pre-

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cipitation was nearly complete, several 2 mgrm. portions of Pb as $Pb(NO_3)_2$ were evaporated to fuming with 5 cc. H_2SO_4 (1·84), and the clear solutions obtained were poured into varying amounts of water; the mixtures were cooled, shaken, allowed to stand for a few minutes, filtered, made alkaline with NH_4OH, and treated with H_2S; with 10, 15, and 20 cc. water, the final alkaline solution remained almost colourless when treated with H_2S, thus showing that the amount of lead remaining in the filtrate was scarcely appreciable; when as much water as 50 cc. was used, the liquid was much darkened by H_2S, and a small precipitate of PbS separated on standing.

Influence of HNO_3 *on the Solubility of* $PbSO_4$.—See C. E., P. 23, N. 6.

To each of several solutions containing 1 mgrm. Pb as $Pb(NO_3)_2$ in 5 cc. HNO_3 (1·20) and 15 cc. water were added 2 cc. of H_2SO_4 (1·84); the mixture was shaken violently, and allowed to stand; only in one or two cases did a precipitate of $PbSO_4$ separate within ten minutes. Three cc. more H_2SO_4 were then added to the solutions that remained clear; $PbSO_4$ precipitated in every case. The experiment was repeated, except that 2 mgrms. Pb were taken; a precipitate of $PbSO_4$ separated when the 2 cc. H_2SO_4 were added. To 1 or 2 mgrms. Pb in 10 cc. HNO_3 (1·20) and 10 cc. water 2 cc. H_2SO_4 were added; no precipitate resulted. Three cc. H_2SO_4 more were added; when 2 mgrms. Pb were present, a precipitate formed. The last experiment was repeated with 4 mgrms. Pb, using 2 cc. H_2SO_4 (1·84); a precipitate of $PbSO_4$ separated.

P. 26, N. 2: *Separation of Bismuth from* H_2SO_4 *Solutions.*—500 mgrms. Bi as nitrate were evaporated to fuming with 5 cc. H_2SO_4 (1·84), and cooled; a large quantity of a white solid separated. The mixture was added to 20 cc. cold water, and cooled; almost all dissolved, only a very small white residue (2 to 3 mgrms.) being left, which was proved by P. 14 not to be $PbSO_4$; but on standing overnight a large coarsely crystalline white precipitate (probably bismuth oxysulphate) separated. This was filtered off, and the filtrate made alkaline with NH_4OH; a precipitate estimated to contain 40 to 80 mgrms. Bi separated. In another experiment the filtrate, instead of being treated with NH_4OH, was diluted with two volumes of water, and allowed to stand; more of the precipitate separated slowly. The experiment was repeated, except that the clear solution obtained on dilution with cold water was heated to boiling; a large white precipitate separated at once, which was similar in appearance to that obtained in the former experiment; this did not dissolve when the solution was cooled and shaken. Separate portions of the white precipitates which had separated in the preceding experiments from the dilute H_2SO_4 solution on standing, and on heating were treated with 30 to 40 cc. cold H_2SO_4 (1·20); the precipitates dissolved only slightly, even on standing. The undissolved precipitates still containing about 300 mgrms. Bi were collected on filters, and about 10 cc. HCl (1·12) poured over each; clear solutions were quickly obtained.

P. 27, N. 1: *Non-precipitation of Small Quantities of Antimony by* NH_4OH.—Compare C. E., P. 23, N. 7.

Ten mgrms. Sb as $SbCl_3$ and 2 cc. H_2SO_4 (1·84) were added to 10 cc. water; the mixture was evaporated to fuming, cooled, diluted to 15 cc., made just alkaline with NH_4OH, and allowed to stand for thirty minutes; no precipitate separated; but when 10 cc. more NH_4OH (0·96) were added, a very slight white precipitate separated. The experiment was repeated, except that the $SbCl_3$ solution was first warmed with $HCl + HNO_3$ to convert it into the antimonic state; no precipitate separated from the NH_4OH solution, even on standing.

P. 27, N. 2: *Complex Copper-ammonia and Cadmium-ammonia Cations.*—See Dawson and McCrae (*Journ. Chem. Soc.*, 1900, lxxvii., 1239); Euler (*Ber.*, 1903, xxxvi., 3400); Bonsdorff (*Zeit. Anorg. Chem.*, 1904, lxi., 132); Locke and Forssell, (*Am. Chem. Journ.*, 1904, xxxi., 268).

P. 28, N. 1: *Precipitation of* BiOCl.—To 0·25 cc. HCl (1·20) was added 1 mgrm. Bi as chloride, and the solution poured into 100 cc. water at 60°; a precipitate of BiOCl appeared in about a minute. After five minutes the solution was filtered, made alkaline with NH_4OH, and treated with H_2S; no precipitate formed. The experiment was repeated, using 0·5 cc. HCl (1·20) instead of 0·25 cc.; no precipitate of BiOCl formed in five minutes. It was again repeated, using 0·5 cc. HCl and 2 mgrms. Bi; a precipitate of Bi had formed after five minutes, but the filtrate also gave a precipitate with H_2S. It was again repeated, using 1 cc. HCl (1·20) and 6 and 8 mgrms. Bi; with 8 mgrms. Bi a precipitate formed, but not with 6 mgrms.

In a number of experiments 1 mgrm. Bi dissolved in 0·25 cc. HCl (1·20) was poured into 100 cc. water at various temperatures; a precipitate of BiOCl appeared in less than one minute when the temperature was 55°, 70°, 80°, or 90°, in about two minutes at 45°, in about five minutes at 25°, and only after ten to fifteen minutes at 15°.

P. 28, N. 2: *Decomposition of Sodium Stannite Solution.*—A sodium stannite solution was prepared as directed and kept in a stoppered bottle for a week; a black crystalline deposit appeared at the bottom of the bottle.

P. 28, N. 3: *Action of Sodium Stannite on* BiOCl.—Vanino and Treubert (*Ber.*, 1898, xxxi., 1113) have shown that the black precipitate formed by the action of a stannite solution is metallic bismuth, and not BiO, as was formerly supposed to be the case.

0·5 mgrm. Bi as $BiCl_3$ was added in one experiment to 100 cc. water, and in a second one to 500 cc. water; the precipitate formed (which was scarcely visible in the second case) was collected on a filter, washed with water, and then treated with Na_2SnO_2; the greater part of the filter was at once blackened.

Ten mgrms. Pb as $Pb(OH)_2$ were treated on a filter first with a cold Na_2SnO_2 solution, and then with a solution at about 60°; in the first case no blackening occurred in several minutes, while in the second it occurred almost immediately.

The experiment was repeated with 20 mgrms. Sb as antimonous, and with 20 mgrms. Sb as antimonic hydroxide; no blackening was observed in either case.

The experiment with cold Na_2SnO_2 was repeated with 2 mgrms. Fe as $Fe(OH)_3$; the red precipitate did not change colour in ten minutes, but, when hot Na_2SnO_2 was poured over it, it slowly became darker.

P. 29, N. 1: *Precipitation of Copper Ferrocyanide in the presence of a Cadmium Salt.*—A solution containing 1 mgrm. Cu as $CuSO_4$, 500 mgrms. Cd as $Cd(NO_3)_2$, and 2 cc. H_2SO_4 (1·84) was made alkaline with NH_4OH; the solution remained colourless. One-fourth of the solution (about 10 cc.) was acidified with acetic acid, and two drops of a 4 per cent $K_4Fe(CN)_6$ solution added; a white precipitate separated, which had at first only a slight pink tinge, but this colour deepened, and was very apparent after ten minutes. Excess of $K_4Fe(CN)_6$ was then added; much more of the white precipitate separated, and the pink colour of the copper salt was almost obscured. The experiment was repeated, except that only 0·5 mgrm. Cu was taken; the result was exactly the same, thus showing that this test is a very delicate one, provided only two to three drops of $K_4Fe(CN)_6$ solution are first added.

P. 29, N. 2: *Precipitation of Molybdenum by Potassium Ferrocyanide.*—One and 100 mgrms. Mo as MoO_3, and 1 and 10 mgrms. U as $UO_2(C_2H_3O_2)_2$, in separate experiments were dissolved in 2 cc. NH_4OH (0·96), the solutions made acid with acetic acid, and several drops of $K_4Fe(CN)_6$ solution added; no change was observed. The experiments were repeated, except that the NH_4OH solution was acidified with HCl instead of with acetic acid; with the 100 mgrms. Mo and the 10 mgrms. U a large dark red precipitate separated at once; with the 1 mgrm. portions a deep red solution was obtained, from which a dark red precipitate separated after a minute or two.

P. 30, N. 1 and 2: *Complex Cuprocyanide and Cadmicyanide Anions.*—See Euler (*Ber.*, 1903, xxxvi., 3404); Bodländer (*Ber.*, 1903, xxxvi., 3933).

P. 30, N. 3: *Behaviour of Mercury, Lead, and Bismuth in the Cadmium Test with* H_2S.—One mgrm. Hg, 1 mgrm.

Pb, and 1 mgrm. Bi were treated in separate experiments by P. 26, 27, and 30, filtering immediately after the addition of H_2SO_4 and of NH_4OH; there resulted a precipitate with H_2SO_4 in the case of lead and with NH_4OH in the case of bismuth, but none in the case of mercury with these reagents. With H_2S in the KCN solution small dark brown precipitates formed in the lead solution and in the mercury solution, and a very small black one in the bismuth solution. The experiment was repeated with 150 mgrms. Pb and with 150 mgrms. Bi, the precipitates of $PbSO_4$ and of $(BiO)_2SO_4$ and $Bi(OH)_3$ being filtered after cooling and standing a few minutes; even less precipitate resulted in each case than when only 1 mgrm. was used.

Separation of CdS *from Black Sulphides by Dilute* H_2SO_4.—One mgrm. Cd as CdS, freshly precipitated by H_2S from an NH_4OH solution, was boiled gently for about five minutes with 20 cc. of a mixture of one volume of H_2SO_4 (1·20) with four volumes of water; the solution was filtered, diluted with two to three times its volume of water, and saturated with H_2S in the cold; a yellow precipitate of CdS separated.

The experiment was repeated, except that in separate experiments 1 mgrm. Cu, 1 mgrm. Pb, and 1 mgrm. Hg were mixed with 1 mgrm. Cd; a distinctly yellow precipitate was obtained in each experiment.

About 50 mgrms. Cd as CdS were boiled for five minutes with 20 cc. of a mixture of one volume H_2SO_4 (1·20) and four volumes of water; the sulphide did not dissolve completely.

(To be continued).

SOCIETY OF CHEMICAL INDUSTRY.

(LONDON SECTION).

Ordinary Meeting, June 3rd, 1907.

Mr. R. J. FRISWELL in the Chair.

"*The Nature of the Changes Involved in the Production and Setting of Plaster-of-Paris.*" By W. A. DAVIS.

The contradictory character of the present knowledge of this problem is first discussed. Data are then adduced to show that the first change occurring in the dehydration of gypsum is the formation of a new orthorhombic form of the dehydrate, $CaSO_4,2H_2O$, which by loss of water subsequently gives the half hydrate, $CaSO_4,\frac{1}{2}H_2O$ (the essential constituent of ordinary plaster). The so-called "soluble anhydrite" is produced from gypsum, not directly as supposed by van't Hoff, but as a product of the further dehydration of the half hydrate. The conditions under which this change occurs and the manner in which it may be reversed are dealt with in detail. In the setting of plaster, gypsum is not immediately regenerated, but the second form of the dehydrate referred to above is first produced; it undergoes change into gypsum subsequently. Many of van't Hoff's conclusions concerning the changes occurring in the dehydration of gypsum are shown to be invalidated by incorrect assumptions; the problem being much more complicated than hitherto supposed.

"*The Influence of Temperature of Dyeing on Resolution.*" By W. B. DRAPER and A. WILSON.

Basic colours are absorbed by silk fibre in two ways. Above 40° a more permanent absorption of part of the dye takes place, which increases up to 100°. A similar effect is noticed with acid dyes on silk. Preliminary boiling with water or acid does not influence subsequent dyeing at low temperatures. A similar result is obtained with direct colours on cotton, so the reaction is a general one. The effect is absent when dyeing in alcohol. Fastness against light does not follow the temperature in same way.

"*Analysis of White Lead.*" By W. A. DAVIS and C. A. KLEIN.

The authors have investigated the sources of error in the different methods used in the analysis of white lead. These errors are much smaller in the case of dry white lead than in that of white lead ground in oil. In the latter case it is impossible to extract the oil completely, a small quantity (0·3 per cent) always remaining undissolved. This residual "oil" causes the results for CO_2 and H_2O obtained by the combustion method to be high—in the case of CO_2 an error of nearly 1 per cent may be so caused. Another and even more important source of error is the fact that white lead in contact with oil gradually undergoes a change in composition, so that analyses obtained with the same sample at different times give different results. Details are given of two methods for the accurate estimation of CO_2 in *dry* white lead, and also of a method for directly determining combined water.

"*The Loss of Nitre in the Chamber Process.*" (Part III.). By J. K. H. INGLIS.

The author, in continuation of earlier papers, has again analysed samples of the exit gases from sulphuric acid chambers by means of fractional distillation at low temperatures. Indirect analyses were almost completely avoided, and the results show the presence of small quantities of nitrous oxide and of appreciable quantities of higher oxides, the quantity of nitric oxide being considerable when the sulphur escape is high. There is still a considerable quantity of nitre unaccounted for, its loss being either due to reduction to nitrogen or to the whole of the nitric acid not being collected in this method of analysis.

"*Calorimeter for Volatile Liquid Fuels, Specially adapted for Petrol.*" By W. HANSEN RAWLES.

A development of the Darling calorimeter.

The liquid is burnt in a small brass lamp having asbestos wick and cap.

The combustion chamber stopper carries an electrical conductor for igniting the liquid and a rod to remove the lamp cap.

During the combustion the lamp is surrounded by cold water, which is finally driven by oxygen pressure into the outer vessel.

The gases bubble out from the base of apparatus into the outer water, run up a copper arch-sectioned spiral (round the combustion chamber), and escape into the air. Efficient absorption of heat is ensured.

This calorimeter, which was made for the author by A. Gallenkamp and Co., is applicable to solid and liquid fuels.

FARADAY SOCIETY.

Ordinary Meeting, May 28th, 1907.

Prof. A. K. HUNTINGTON in the Chair.

A PAPER entitled "*Contributions to the Chemistry of Gold,*" by Mr. F. H. CAMPBELL, M.Sc., was read in abstract by Mr. N. T. M. WILSMORE, M.Sc. (Will be inserted in full).

Dr. F. MOLLWO PERKIN read a paper on "*Reduction of some Oxides and Sulphides by means of Metallic Calcium.*"

The author first referred to the well-known powerful reducing action of aluminium, as, for example, its use in the preparation of chromium, ferrosilicon, and other metals and alloys, and its use in the form of "thermite" for welding purposes. He finds that metallic calcium is a still more powerful reducing agent than aluminium. For example, when molecular proportions of aluminium and ferric oxide are mixed together and ignited by means of a fuse of aluminium and barium peroxide, intense reaction ensues, and continues until all the oxygen has been removed from the ferric oxide, and aluminium oxide and metallic iron produced in its stead. When metallic calcium in the form of fine turnings is mixed with ferric oxide and ignited in a similar manner, the reaction is so intense that

the mixture is in large part ejected from the crucible. The reaction can be brought under control by mixing 30 to 40 per cent of calcium fluoride or 10 to 20 per cent of calcium oxide with the contents of the crucible. Boron can be obtained by igniting a mixture of boron trioxide with the calculated quantity of calcium and 5 to 10 per cent of calcium oxide. If no calcium oxide is added the reaction is too violent. It is, however, very difficult entirely to free the boron from calcium even after standing over hydrochloric acid for weeks; the boron invariably contains considerable quantities of calcium, which is probably present as calcium boride. When borax is carefully dried and mixed with calcium, and the mixture ignited by a fuse, the reaction completes itself without undue violence. On treating the reaction mixture with hydrochloric acid, brown amorphous boron is obtained in almost theoretical quantities; the product, however, always contains calcium, but can be used for preparing boron chloride and similar compounds. Rather anomalous results were obtained when sand (silicon dioxide) was ignited with calcium. Unless considerably less than the theoretical amount of calcium was used, not silicon but probably calcium silicide was obtained, because when the reaction mixture is placed in hydrochloric acid, large quantities of a spontaneously inflammable gas are given off; this gas is probably silicon hydride. The product remaining behind is silicic acid and calcium chloride. The results were the same when a mixture of aluminium and calcium was employed.

Attention was also drawn to the difficulty experienced in causing silica in the form of fine sand to react with metallic aluminium which was in the form of a rough powder. A similar difficulty was met with in the case of boric anhydride and aluminium. Galena does not yield metallic lead and calcium sulphide, but a greyish mass which gives off sulphuretted hydrogen when acted upon with acids, lead in the form of a salt being left in solution. Red phosphorus and calcium unite with explosive violence. Sulphur and calcium also react with great vigour. Manganese dioxide and calcium require to be mixed with 30 to 40 per cent of calcium fluoride, when a regulus of manganese can be obtained, otherwise the reaction is too violent. This is also the case with chromium oxide. When the experiments were first tried it was found that the reaction mixture always stuck to the crucible, and it was invariably necessary to break the crucible in order to obtain the product. Subsequently the difficulty was got over by lining the crucible with a paste made from slake lime and a strong solution of sodium silicate (water-glass); in the case of boron the solution used was generally borax. The crucible and lining were thoroughly dried, and were then ready for use. With crucibles so prepared there was never any difficulty in getting out the reaction product in the form of a lump without breaking the crucible.

Mr. F. E. WESTON said that he had succeeded in reducing silica in the form of kieselguhr by means of aluminium. He had recently used aluminium in the reduction of titanium compounds.

Mr. W. P. DIGBY asked whether calcium would, like aluminium, prevent segregation in steel castings.

Prof. A. K. HUNTINGTON said that the state of division of the materials in these experiments was of paramount importance. He believed, answering Mr. Digby, that calcium had not proved a successful substitute for aluminium in pouring steel; the calcium oxide seemed to remain in the metal.

Prior to the Ordinary Meeting the Annual General Meeting of the Society was held, at which the Report of the Council and the Balance Sheet were duly approved, and the following Officers and Council elected for the Session 1907-8:—

President—Sir William Perkin, F.R.S.

Vice Presidents—G. T. Beilby, F.R.S.; R. A. Hadfield; Prof. W. Hittorf; Sir William Huggins, O.M., F.R.S.; Prof. A. K. Huntington; Prof. A. Schuster, F.R.S.; Prof. J. J. Thomson, F.R.S.

Treasurer—F. Mollwo Perkin, Ph.D.

Council—A. C. Claudet; S. Z. de Ferranti; F. W. Harbord; R. S. Hutton; T. M. Lowry; W. Murray Morrison; J. Swinburne, F.R.S.; N. T. M. Wilsmore; Prof. E. Wilson; J. L. F. Vogel.

NOTICES OF BOOKS.

Lubrication and Lubricants. By LEONARD ARCHBUTT, F.I.C., F.C.S., and R. MOUNTFORD DEELEY, M.I.Mech.E., F.G.S. Second Edition. London: Charles Griffin and Co., Ltd. 1907.

THE second edition of this treatise on the theory and practice of lubrication, and on the nature, properties, and testing of lubricants, contains some important fresh matter, both theoretical and practical. The authors have done much valuable pioneer work, and have, moreover, had opportunities of testing different lubricants and appliances for lubrication, and to their own knowledge, which they put at the disposal of their readers, they have added an exhaustive compilation of the researches of others, with the result that the work is of an extremely comprehensive nature. The first edition was at once accepted as practically invaluable to the engineer, and the second fully maintains its high reputation, every endeavour having been made to bring it up-to-date in all respects. The pages on the sources, preparation, and chief properties of mineral oils have been revised by Sir Boverton Redwood, and other experts have assisted the authors with advice and information relating to various oils suitable for the lubrication of different types of machines and engines.

Glues and Gelatine. By R. LIVINGSTON FERNBACH. London: Archibald Constable and Co., Ltd. 1907.

THE author of this book has done a service to manufacturers interested in the use of glue in calling their attention to the frauds which can be, and are, practised upon them, if they are content to entrust their interests into the hands of the glue maker, without attempting to test the value of the material supplied to them. The book contains details regarding the testing of glues for special purposes by chemical and mechanical means, and with its help the consumer should be able to acquire some idea whether he is getting full value for his money. The analytical operations are described sufficiently fully to enable a manager or foreman to understand something of the methods and results of analysis, although not to qualify as an analyst. The manufacture of glue is not discussed, the author being of the opinion that for the present old rule-of-thumb methods cannot be altogether supplanted by scientific procedure; however, when consumers have clearer ideas as to the standards they are entitled to expect the article delivered to them to come up to, an advance towards the adoption of more scientific methods will have been definitely made, and the author's aim is to collect data and suggest methods upon which these ideas can be based.

Van Nostrand's Chemical Annual, 1907. Edited by JOHN C. OLSEN, A.M., Ph.D. London: Archibald Constable and Co., Ltd. 1907.

THIS handbook contains much valuable information, and will be found a boon to busy men. It is conveniently arranged, and contains all the tables required for ordinary analytical work, together with full reference tables of the physical constants of the most important inorganic and organic compounds, besides specific gravity tables of various solutions, and also useful thermo-chemical data. In addition an attempt has been made to compile a list of the more important articles on chemical subjects which were published between January 1st, 1905, and June 1st,

1906, and this list, which contains more than a thousand references to chemical literature, will undoubtedly be much appreciated. The compilers have exercised an excellent discretion in their work, which will give great assistance to all who wish to keep their knowledge abreast with the times. In addition, a list of important books, published during the same period, is given with the published price, and, in the case of German books, references are frequently given to the number in the *Zeitschrift für Anorganische Chemie* in which reviews may be found. In view of the endeavours which have evidently been made by the compilers to ensure accuracy in other parts of the book, it is surprising to find that these book lists have been carelessly printed. Two misprints in well-known names on the first page raise suspicions as to the correctness of later parts, suspicions which further examination will show are not unjustified. However, this is a simple matter to remedy, and the new annual, it is to be hoped, has a long and useful life before it, for it fills a place at present unoccupied by any book in the English tongue.

Physikalisch-chemische Ubungen. ("Practical Physical Chemistry"). By Dr. W. A. Roth. Hamburg and Leipzig: Leopold Voss. 1907.

The needs of the beginner in the study of physical chemistry have been somewhat overlooked, because, rightly or wrongly, it is regarded frequently as a branch of chemistry which cannot profitably be taken up at an early stage in the student's career, although it has peculiar attractions for the research student, owing to the wide fields of investigation which are waiting for workers. However, this view is perhaps less widely held now than it was a short time ago, and books of elementary practical physical chemistry are beginning to make their appearance, such as the one under review, which is on the whole a satisfactory specimen of its kind. The experimental directions appear to be clear and easily understood, and thermo-chemistry is well treated; throughout the book the connections between the practical results obtained and the theoretical deductions from them are very clearly put before the worker, who is thus prevented as far as possible from degenerating into a follower of directions given in the form of recipes—a tendency in the young student which the elementary practical book has above all to combat. On the other hand, it cannot be said that the book is free from defects, some of which are not of a trivial nature. Among omissions may be specially regretted that of methods of determining viscosity and surface tension, while electrochemistry is treated rather scantily. In describing the determination of vapour density by Victor Meyer's method the old form of apparatus is recommended instead of the new, which is a great improvement upon it, and is now almost universally adopted.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 21, May 27, 1907.

Double Sulphites of Hypovanadic Acid.—Gustave Gain.—The alkaline bases combine easily with hypovanadic acid in presence of sulphurous acid, giving well-defined double sulphites. These are obtained by treating ammonium metavanadate with a saturated solution of sulphurous acid, adding a solution of alkaline bisulphite, and evaporating slowly. In some cases it is necessary to evaporate *in vacuo*. The formulæ of the crystalline compounds prepared thus by the author are—

$$3(SO_2V_2O_4)(SO_2K_2O).5H_2O,$$
$$3(SO_2V_2O_4)SO_2(NH_4)_2O.4H_2O,$$
$$(SO_2V_2O_4)2(SO_2Rb_2O).2H_2O,$$
$$(SO_2V_2O_4)3(SO_2Cs_2O).8H_2O,$$
$$3(SO_2V_2O_4)(SO_2Tl_2O).8H_2O,$$
$$5(SO_2.V_2O_4)(SO_2Na_2O).2H_2O,$$
$$(SO_2V_2O_4)5(SO_2Li_2O).8H_2O.$$

Selenide of Lead.—H. Pélabon.—Lead combines directly with selenium, and the compound thus obtained forms homogeneous mixtures with excess of metal or metalloid. The author has constructed fusibility curves of these mixtures, taking as abscissæ the values R of the ratio of the mass of the selenium to the total mass, and as ordinates the corresponding values of the temperature of solidification of the previously fused mixtures. If R exceeds 5 and continues to increase, the temperature of solidification of the corresponding mixtures increases regularly till it attains its maximum 1065° when R is about 27. This temperature is the melting-point of lead selenide, PbSe, in which R = 27·62. When the amount of selenium varies from 0 to 27 per cent, the liquid obtained by fusing the two substances is a homogeneous mixture of lead selenide, PbSe, and metallic lead. Mixtures which contain more than one atom of selenium to one atom of lead readily lose selenium when heated. For all mixtures in which the amount of selenium present lies between 27 and 45 per cent the temperature of solidification is in the neighbourhood of 673°. When the selenium exceeds 45 per cent the liquid separates into two layers. The denser solidifies at 673°, giving a grey-black solid, while the upper layer is pure selenium with a much lower melting-point. Between 300° and 600° the liquids can readily be separated by decantation, and the selenium thus obtained contains no trace of lead. The analysis of the liquid which solidifies at 673° shows that it is not the compound $PbSe_2$, there being always a slight excess of selenium. It appears to be a saturated solution of selenium in the selenide PbSe, and when it is allowed to solidify *in vacuo* vapours of selenium escape rapidly from the mass.

Methyl Ethers of Allyl and Propargyl Carbinol.—M. Lespieau.—If allyl bromide and chloromethyl ether are added to magnesium in the proportion of 60 grms. of brominated compound, and 40 grms. of chloromethyl ether to 12 grms. of magnesium, the metal will dissolve totally if the whole is well stirred. If then water is added and the liquid distilled, ordinary ether, biallyl, and the compound $CH_2=CH—CH_2—CH_2OCH_3$ are formed. It is almost impossible to separate the last by fractional distillation, but if bromine is first added and the liquid is then distilled the ether $CH_2Br—CHBr—CH_2—CH_2OCH_3$, which boils at 90° under 13 mm., can readily be separated from the tetrabromide of biallyl, which passes over at 180° under the same pressure. The ether $CH_2Br—CHBr—CH_2—CH_2OCH_3$ reacts with sodium ethylate, giving almost equal quantities of the two unsaturated brominated ethers, $CH_2=CBr—CH_2—CH_2OCH_3$ and $CHBr=CH—CH_2—CH_2OCH_3$, both of which when treated with ordinary or alcoholic potash give the true acetylenic compound $CH\equiv C—CH_2—CH_2OCH_3$.

Berichte der Deutschen Chemischen Gesellschaft. Vol. xl., No. 8, 1907.

Diphenylurea Chloride as a Reagent for Phenols.—J. Herzog.—Diphenylurea chloride is an excellent reagent for phenols, with which it forms crystalline compounds. Tertiary alcohols in general do not give this reaction. The behaviour of diphenylurea chloride shows a characteristic difference with the hydroxyl groups of alcohols and those of phenols. Of all the phenols and their derivatives which the author has investigated, the only ones which give no crystalline urethanes are the phenol-carbonic acids. In order to prepare and purify the different phenol-urethanes

the phenol is heated in a flask in boiling water for an hour with four times its weight of pyridine and the molecular weight of diphenylurea chloride; then the solution is stirred with water, when a red crystalline mass is obtained. When the water has been poured off and the crystals have been dried superficially, they are re-crystallised from ligroin or alcohol. The reaction is as follows:—The diphenylurea chloride first forms an addition product with pyridine, which in presence of phenols gives pyridine hydrochloride and phenol urethane:—

$$C_5H_5N<\begin{matrix}Cl\\CO.N<\begin{matrix}C_6H_5\\C_6H_5\end{matrix}\end{matrix}+R.OH=$$

$$=C_5H_5:N<\begin{matrix}Cl\\H\end{matrix}+RO.CO.N<\begin{matrix}C_6H_5\\C_6H_5\end{matrix}.$$

The diphenyl urethanes can very easily be saponified by heating to 100° for two hours with alcoholic potash. They can conveniently be employed for the identification of the phenols, and as the yield of them is very good a weight of 0·1 grm. of phenol is sufficient for its identification by this method.

New Colour Reaction of Ligno-cellulose.—Alvin S. Wheeler.—The salts of nitroaniline give a characteristic blood-red coloration with ligno-cellulose. An aqueous solution of the hydrochloride of nitroaniline (preferably the para-compound) produces first a yellow coloration with materials containing ligno-cellulose, and this yellow colour changes to deep red in a few hours. The best results are obtained in presence of free acid, and if 2 grms. of paranitroaniline are dissolved in 100 cc. of hydrochloric acid of specified gravity 1·06, and this solution is used hot, if ligno-cellulose is present an immediate blood-red coloration is obtained.

2 : 1-Ferro-ferric Oxide.—Otto Hauser.—When ferro-ferric ammonium carbonate, $Fe_2^{II}(NH_4).(CO_3)_3Fe^{III}O,H_2O$, prepared by the method described by the author (*Berichte*, 1905, xxxviii., 2707) is shaken up with hot strong caustic potash, through which a current of coal-gas is passing, a black oxide separates, which can readily be filtered off and washed. This black oxide is not attracted by a magnet and is characterised by its extreme instability in air, which properties distinguish it from the oxides described by Haber and Lefort. Determinations of the iron present as oxide and also the total iron were made, the mean result being 2·97 : 1 of total iron to oxide iron. Thus the existence of the oxide $Fe_6O_7=4FeO.Fe_2O_3$ is proved. The composition of the hydrate dried at 100° is $Fe_6O_7.5H_2O$. The sesquioxide hydrate, which is produced when the above compound is exposed to the air, differs from it in colour, being very much darker. Moreover, it is strongly magnetic. Its formula is $Fe_2O_3.H_2O$. When heated to about 300° it yields the anhydride. The specific gravity of the magnetic sesquioxide hydrate is 3·58, that of the magnetic sesquioxide dried at 300° is 4·35, while when it is heated to a still higher temperature it loses its magnetism and has the specific gravity 5·15. The oxide Fe_6O_7 is the base of the mineral lievrite, which has the composition $(SiO_4)_2(Fe^{III}.OH)(Fe_2^{II}Ca)$, similar to $(CO_3)_3.Fe^{III}O.Fe_2^{II}(NH_4)H_2O$.

Complex Compounds of Organic Imides.—L. Tschugaeff.—If alkali hydroxides are allowed to act upon copper salts (preferably the acetate) and excess of succinimide in aqueous alcoholic solution, a series of characteristic complex substances is obtained, the composition of which may be expressed by the general formula $Cu(Sn)_4Me_2.nH_2O$ or $(Sn)_2Cu.2SnMe.nH_2O$, where Me stands for a metal of the alkali group. The potassium compound is light reddish violet, the rubidium and cæsium compounds are both reddish violet, the sodium compound is blue, and the lithium compound ultramarine blue. In the solid state the compounds are stable; when water is added to them they undergo hydrolysis, and copper hydroxide or basic copper salt separate. In presence of dilute alcohol containing alkali and excess of succinimide the solutions of the complexes are stable. Dilute acids effect the following decomposition of the potassium complex quantitatively:— $K_2CuSn_4+4HA=4SnH+2KA+CuA_2$. The corresponding nickel compounds can be prepared exactly similarly. They are yellow crystalline substances and are decomposed by water more readily than the copper derivatives. These copper and nickel succinimide complexes recall the copper and nickel compounds of biuret. The reddish violet colour of the complex anion $CuSn_4$ seems to be characteristic of the potassium, rubidium, and cæsium compounds, and the blue sodium and lithium compounds cannot belong to the same series. It is noteworthy that the number of molecules of water of crystallisation is even in the case of the potassium, rubidium, and cæsium compounds (6, 2, and 2 respectively), and odd in the case of the sodium and lithium compounds (5 and 1 respectively.)

Compounds of Pentavalent Chromium. (III.).—R. F. Weinland and Max Fiederer.—When glacial acetic acid is saturated with hydrochloric acid, chromic acid is dissolved in it and allowed to stand for some time, and then pyridine (dissolved in hydrochloric and acetic acids) is added, a salt separates out in reddish brown flakes. This salt has the formula $CrOCl_3.C_5H_5N.HCl$, and is identical with the salt the authors obtained from aqueous hydrochloric acid. The quinoline salt, $CrOCl_3.C_9H_7N.HCl$, obtained from an aqueous solution contains two molecules of water of crystallisation, while when prepared by the glacial acetic acid method it contains no water. The alkali salts of the type $CrOCl_3.2KCl$ can also be prepared more conveniently by the glacial acetic acid than by the aqueous method.

Complex Compounds of Pentavalent Vanadium with Tetravalent Elements.—Wilhelm Prandtl.—When stannic chloride solution is added to sodium orthovanadate solution, and the mixture is neutralised, an amorphous yellow precipitate separates. It is soluble in alkalis and acids and is decomposed by water. When a large excess of vanadium is present during the precipitation it has the formula $3SnO_2.V_2O_5.Na_2O.xH_2O$ or $4SnO_2.V_2O_5.Na_2O.xH_2O$. When this yellow stannic vanadate is dissolved in hot concentrated caustic soda white crystalline needles separate. These are compounds of sodium stannate and sodium orthovanadate, or sodium stannate-vanadates, containing large quantities of water of crystallisation. They are of varying composition, and according to the proportions of the reagents and the temperature and concentration of the solutions, crystals containing more or less tin are obtained, their formulæ being $Na_2SnO_3.3Na_3VO_4.32H_2O$, $Na_2SnO_3.4Na_3VO_4.48H_2O$, $Na_2SnO_3.5Na_3VO_4.64H_2O$, $Na_2SnO_3.6Na_3VO_4.80H_2O$, The tendency of sodium stannate vanadates to form supersaturated solutions is very marked. When their dilute solutions are evaporated, they yield hard, transparent, prismatic crystals of any desired size. Concentrated solutions often do not crystallise for days, but the addition of a small crystal causes them to solidify at once. They take up carbon dioxide in air, and when kept in a desiccator over sulphuric acid, the crystals crumble to a white powder and lose all their water of crystallisation. Analogous potassium or ammonium stannate-vanadates could not be prepared, but when sodium stannate and sodium phosphate or arsenate in alkaline solution were mixed, or when stannic phosphate or arsenate was dissolved in caustic soda, white crystalline salts of the following composition were obtained:—$Na_2SnO_3.4Na_3PO_4.48H_2O$, $Na_2SnO_3.5Na_3PO_4.60H_2O$, $Na_2SnO_3.6Na_3PO_4.72H_2O$, $Na_2SnO_3.4Na_3(P,V)O_4.48H_2O$, $Na_2SnO_3.5Na_3AsO_4.60H_2O$. The two minerals—dahllite, $CO_2.2P_2O_5.7CaO.\frac{1}{2}H_2O$, and staffelite, $CO_2.3P_2O_5.9CaO.CaF_2.H_2O$—are analogous to these compounds of sodium stannate with sodium orthovanadate, phosphate, and arsenate. If the fluorine of staffelite is replaced by the equivalent quantity of oxygen, their formulæ may be written $CaCO_3.2Ca_3(PO_4)_2.\frac{1}{2}H_2O$ (dahllite) and $CaCO_3.3Ca_3(PO_4)_2.H_2O$ (staffelite). The difference between the two compounds is one molecule of calcium orthophosphate $Ca_3(PO_4)_2.\frac{1}{2}H_2O$.

Anhydrous Thiocyanic Acid.—Arthur Rosenheim and Richard Levy.—Klason's method of preparing anhydrous thiocyanic acid by leading the vapour of a ten per cent aqueous acid solution over calcium chloride warmed to 40° and then cooling strongly, leads to the formation of a mixture of condensed sulphuretted hydrogen, sulphur dioxide, carbon disulphide, and hydrogen cyanide, containing 40 or 50 per cent of thiocyanic acid. If, however, dehydrated powdered potassium thiocyanide is mixed with its own weight of phosphorus pentoxide in a distilling flask, and the delivery tube is connected with a small gas washing flask which can be cooled in a Dewar's vessel, and the whole is well cooled, the whole apparatus being filled with hydrogen, upon allowing sulphuric acid to drop into the flask colourless fumes are evolved which condense to a white crystalline mass. The vapours in the distilling tube gradually turn yellow and then red, and the contents of the flask also turn yellow, owing to the formation of decomposition products of thiocyanic acid. The analysis of the white crystalline mass shows that it consists only of thiocyanic acid. It can be kept for hours in a closed tube at 0°. Above this temperature it quickly fuses, turning yellow, the melting-point being about 5°. The acid has an irritating smell, and it has strong corrosive action on the skin.

MEETINGS FOR THE WEEK.

TUESDAY, 25th.—Faraday Society, 8. "Thermo-chemistry of Electrolysis in Relation to the Hydrate Theory of Ionisation," by W. R. Bousfield and T. M. Lowry. "Influence of Non-electrolytes and Electrolytes in the Solubility of Gases in Water—The Question of Hydrates in Solution," by J. C. Philip. "Dissociation of Hydrates as indicated by their Equilibrium Curves," by A. Findlay. "Hydrates in Solution - Discussion of Methods proposed for Determining Degree of Hydration," by G. Senter. General Discussion on Hydrates in Solution.

FRIDAY, 28th.—Physical, 5. (At the City and Guilds' Central Technical College, Exhibition Road). J. T. Irwin—Demonstration of the uses of his Hot-wire Oscillographs and Hot-wire Wattmeters. J. S. Dow—(1) A Cosine Flicker Photometer; (2) Some Phenomena in Colour Vision. W. E. Ayrton and T. Mather—(1) Description and Exhibition of Student's Apparatus for Measuring Permeability and Hysteresis; (2) Design of Chokers.

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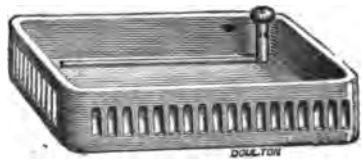

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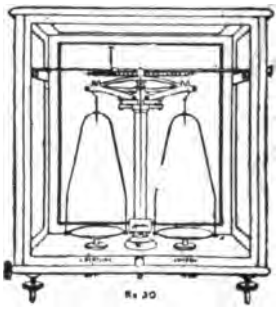

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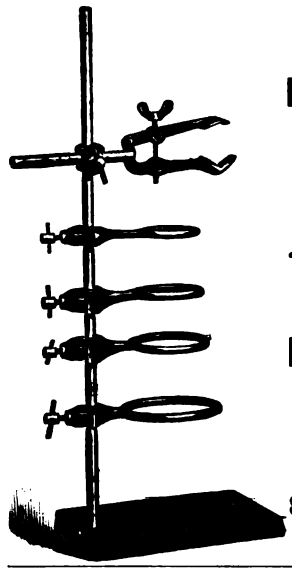

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ON THE CALCULATION OF PHYSICO-CHEMICAL CONSTANTS.

By H. STANLEY REDGROVE, F.C.S.

THERMO-CHEMICAL CONSTANTS OF THE HYDROCARBONS.

THE heat of combustion of a hydrocarbon is derived from several sources. Consider the case of the general hydrocarbon,—

$$nC + 2(n+1-a-2b-p)H + (n+p-a-b-1)L_1 + aL_2 + bL_3$$

The heat of combustion of one molecule of this hydrocarbon is the algebraic sum of the following heats:—

1. The heat due to the severance of $2(n+1-a-2b-p)$ C . H links.
2. The heat due to the severance of $\frac{1}{2}(n+1-a-2b-p)$ O : O links.
3. The heat of formation of $(n+1-a-2b-p)$ molecules of water from H and O atoms.
4. The heat due to the severance of $(n+p-a-b-1)$ C . C links.
5. The heat due to the severance of a C : C links.
6. The heat due to the severance of b C : C links.
7. The heat due to the severance of n O : O links.
8. The heat of formation of n molecules CO_2 from C and O atoms.

The coefficients of the Heats 1, 2, and 3 are always in the ratio 2 : ½ : 1; therefore their algebraic sum can be considered as one constant; likewise the algebraic sum of Heats 7 and 8 may be considered as one constant.

Dealing with grm.-molecular weights, and using the notation already adopted:—Σ Heats 1, 2, and 3 = $2(n+1-a-2b-p)$ H cals. Heat 4 = $(n+p-a-b-1)L_1$ cals. Heat 5 = aL_2 cals. Heat 6 = $6L_3$ cals. Σ Heats 7, 8 = nC cals.

The author has already shown that the values of these constants are unknown; the values of the "fundamental constants" $\alpha(=C+4H)$, $\beta(=2H-L_1)$, $\gamma(=4H-L_2)$, and $\delta(=6H-L_3)$ (CHEMICAL NEWS, vol. xcv., p. 193, see Note) can, however, be easily calculated thus:—

The value of $\alpha = C+4H$ (methane) can be found experimentally.

The difference between the molecular heats of combustion of two adjacent homologues gives $C+2H+L_1$, thus:—

Ethane—methane = (369·0 − 210·8) cals. = 158·2 cals.
Propane—ethane = (527·5 − 369·0) cals. = 158·5 cals., &c.
$C+4H-(C+2H+L_1) = 2H-L_1 = \beta$.

(NOTE.—In order to perfectly justify this statement with regard to thermo-chemistry, it is necessary to point out wherein Thomsen's system fails. No long discussion will be attempted, as several criticisms from other authors have already appeared. Thomsen's calculations appear to contain two assumptions, which are not justified:—1. That CO has the formula C=O; *à priori* C≡O is equally as likely; and, moreover, what little evidence we have appears to be in favour of this latter alternative. 2. That the heat of formation of one molecule CO from one atom C and one atom O, equals the heat of formation of one molecule CO_2 from one molecule CO and one atom O. Thomsen has himself shown (according to his system) that the thermal value of O varies according to the groups with which it is combined, rendering the above assumption inadmissable).

TABLE I.—HYDROCARBONS.

1. Hydrocarbon.	2. Formulæ.	3.	4. M.H.C., constant volume (Thomsen). Cals.	5. M.H.C. calculated. Cals.	6. Diff. between cols. 4 and 5. Cals.	7. Percentage error.	8. Valency number (W).	9. (M.H.C) + W. Cals.	10. W × 26·25. Cals.	11. Diff. between cols. 4 and 10. Cals.
Methane	$C+4H$	α	210·8	210·8	0·0	0·00	8	26·4	210·0	−0·8
Ethane	$2C+6H+L_1$	$2\alpha-\beta$	369·0	369·1	+0·1	+0·03	14	26·3	367·5	1·5
Propane	$3C+8H+2L_1$	$3\alpha-2\beta$	527·4	527·4	−0·1	−0·02	20	26·4	525·0	2·5
Trimethylmethane	$4C+10H+3L_1$	$4\alpha-3\beta$	685·2	685·7	+0·5	+0·07	26	26·4	682·5	2·7
Tetramethylmethane	$5C+12H+4L_1$	$5\alpha-4\beta$	844·8	844·0	−0·8	−0·09	32	26·4	840·0	4·8
Di-isopropyl	$6C+14H+5L_1$	$6\alpha-5\beta$	997·2	1002·3	+5·1	+0·51	38	26·2	997·5	+0·3
Ethylene	$2C+4H+L_2$	$2\alpha-\gamma$	332·2	332·6	+0·4	+0·12	12	27·7	315·0	−17·2
Propylene	$3C+6H+L_1+L_2$	$3\alpha-\beta-\gamma$	491·3	490·9	−0·4	−0·08	18	27·3	472·5	18·8
Trimethylene	$3C+6H+3L_1$	$3\alpha-3\beta$	498·0	474·9	−23·1	−4·64	18	27·7	472·5	25·5
iso-Butylene	$4C+8H+2L_1+L_2$	$4\alpha-2\beta-\gamma$	648·9	649·2	+0·3	+0·05	24	27·0	630·0	18·9
iso-Amylene	$5C+10H+3L_1+L_2$	$5\alpha-3\beta-\gamma$	806·2	807·5	+1·3	+0·16	30	26·9	787·5	18·7
Diallyl	$6C+10H+3L_1+2L_2$	$6\alpha-3\beta-2\gamma$	930·8	929·3	−1·5	−0·16	34	27·4	892·5	37·3
Acetylene	$2C+2H+L_3$	$2\alpha-\delta$	309·2	308·6	−0·6	−0·19	10	30·9	262·5	46·7
Allylene	$3C+4H+L_1+L_3$	$3\alpha-\beta-\delta$	466·4	466·9	+0·5	+0·11	16	29·2	420·0	46·4
Dipropargyl	$6C+6H+3L_1+2L_3$	$6\alpha-3\beta-2\delta$	881·4	881·3	−0·1	−0·01	30	29·4	787·5	93·9
Benzene	*$6C+6H+3L_1+3L_2$	$6\alpha-3\beta-3\gamma$	797·9	840·3	+42·4		30	26·6	787·5	10·4
	†$6C+6H+9L_1$	$6\alpha-9\beta$		792·3	−5·6					
Toluene	*$7C+8H+4L_1+3L_2$	$7\alpha-4\beta-3\gamma$	953·9	998·6	+44·7		36	26·5	945·0	8·9
	†$7C+8H+10L_1$	$7\alpha-10\beta$		950·6	−3·3					
Mesitylene	*$9C+12H+6L_1+3L_2$	$9\alpha-6\beta-3\gamma$	1280·0	1315·2	+35·2		48	26·7	1260·0	20·0
	†$9C+12H+12L_1$	$9\alpha-12\beta$		1267·2	−12·8					
Pseudocumene	*$9C+12H+6L_1+3L_2$	$9\alpha-6\beta-3\gamma$	1279·2	1315·2	+36·0		48	26·7	1260·0	19·2
	†$9C+12H+12L_1$	$9\alpha-12\beta$		1267·2	−12·0					

* Kekulé's formula. † Ladenburg's or Claus's formula (without adding the value due to tension).

The difference between the molecular heats of combustion of a saturated hydrocarbon, $nC+(2n+2)H+(n-1)L_1$, and the two corresponding unsaturated hydrocarbons, $nC+2nH+(n-2)L_1+L_2$ and $nC+(2n-2)H+(n-2)L_1+L_3$, gives $2H+L_1-L_2$ and $4H+L_1-L_3$.

$$(2H+L_1-L_2)+(2H-L_1) = 4H-L_2 = \gamma.$$
$$(4H+L_1-L_3)+(2H-L_1) = 6H-L_3 = \delta.$$

Or the values of the various hydrocarbons may be equated to the hydrocarbons (for which they are respectively obtained) in terms of the fundamental constants, and the equations solved in any convenient manner.

In order to obtain correct results, if the molecular heats of combustion have been found experimentally for constant pressure, a correction must be applied for constant volume.

In Table I. will be found the molecular heats of combustion of several hydrocarbons found by Thomsen ("Thermo-chemical Researches," 1906, German Edition); those not already corrected by him have been corrected by the author.

The values of the "fundamental constants" calculated from these results are:—α = 210·8 cals., β = 52·5 cals., γ = 89·0 cals., δ = 113·0 cals.

(The values already published were calculated for uncorrected molecular heats of combustion, and are therefore slightly higher than the above. They are sufficiently accurate for approximate calculations).

The molecular heats of combustion of the hydrocarbons have been calculated from these values, with the following interesting results (see Table I.).

Out of fifteen aliphatic hydrocarbons, the error in the case of thirteen is below 0·2 per cent, proving the additive nature of molecular heats of combustion. The error in the case of di-isopropyl is only about 0·5 per cent, and is probably experimental. The very large difference between the experimental and calculated values for trimethylene cannot be thus explained; the question will be considered hereinafter.

In passing we may notice an interesting hypothesis lately proposed by Gervaise le Bas (*Proc. Chem. Soc.*, xxiii., 134) of which only a preliminary note has appeared.

This author states that the heats due to the dissociation of the atoms (*i.e.*, the severance of the linkages) are negligibly small compared to the heats due to the combination of the dissociated atoms with oxygen. As the values of these respective heats are unknown this statement is pure assumption, and is proved to be wrong by the fact that the differences between the various carbon links have considerably large values, showing that at least two out of the three forms of carbon links have considerably large values.

The hypothesis referred to is, the molecular heats of combustion of hydrocarbons are proportional to their valency numbers W; the author cites as an example that the molecular heat of combustion of a normal paraffin, C_nH_{2n+2}, in the gaseous state is given by the expression M.H.C. = $(6n+2)c = Wc$; where c = heat equivalent of one hydrogen atom in large calories. He uses the value c = 26·46 (mean). The heat equivalent of a hydrogen atom is, however, unknown, but c approximately = $\frac{1}{4}\beta = H - \frac{1}{4}L_1$; making this alteration, the above expression is correct, but it does not hold for unsaturated hydrocarbons, and appears to be only a lengthy way of stating that $4\beta = \alpha$ (approximately).

One would naturally think that any laws relating to molecular heats of combustion would hold for true molecular heats of combustion, *i.e.*, at constant volume.

In Table I. is given (M.H.C. ÷ W) and Wc for the corrected values, in which case c = 26·25. The figures speak for themselves.

To return, however, to a consideration of trimethylene. If a C : C link were a double link in an arithmetical sense we should have $L_2 - 2L_1 = 0$, whereas actually $L_2 - 2L_1 = 2(2H - L_1) - (4H - L_2) = 2\beta - \gamma$ = 16·0 cals. similarly, $L_3 - 3L_1$ = 44·5 cals. We know, however, from pure chemistry that a "double" link is not an arithmetical double link, but in so far as stablility is concerned less than a single link.

Thermo-chemistry is in agreement with this fact; for, as we should suppose, less energy is required to sever an unstable bond, or more energy is given out at its severance, than in the case of a stable bond.

The instability of C : C and C ⋮ C links find a mathematical interpretation in von Baeyer's tension theory. Accepting this theory we know that although a C : C link consists of two single links, it is also productive of a certain amount of tension, which renders it less stable than a single link; if we represent the thermal value of this tension by T_2, then $2L_1 + T_2 = L_2$, whence T_2 = 16·0 cals. Similarly, if T_3 is the tension in a C ⋮ C link, then $3L_1 + T_3 = L_3$, whence T_3 = 44·5 cals.

In trimethylene, although there are no C : C or C ⋮ C links, we know from Baeyer's tension theory that a certain amount of tension is produced in it, thus explaining the instability of the substance. Consequently, the molecular heat of combustion of trimethylene will be greater than $3C+6H+3L_1$ (= 474·9 cals.) by the thermal value of this tension, which is given by experiment as 23·1 cals.

Turning our attention to the aromatic hydrocarbons, we find, as we should expect, Kekulé's formula gives too high values. The formula $6C+6H+9L_1$ (Ladenburg's or Claus's), for benzene gives fairly good values apparently at first sight.

Applying, however, the knowledge gained relative to tension we are led to the conclusion that Ladenburg's formula would give very much higher values than those calculated on the supposition that benzene is $6C+6H+9L_1$, for a substance having Ladenburg's formula would contain two trimethylene rings and three tetramethylene rings; consequently, we must add to the values calculated as above the thermal value of the tension thus produced, which must be greater than 2(23·1) cals., *i.e.*, 46·2 cals. The true theoretical values would therefore be over 30 to 40 cals. too high.

Claus's formula also contains tetra-methylene rings, which would cause the theoretical values to be higher than calculated on the supposition that benzene is $6C+6H+9L_1$.

The thermo-chemistry of benzene is in agreement with the pure chemistry of the substance, showing, as it does, its saturated and stable nature. Comparing the molecular heats of combustion found experimentally with those calculated for the fully saturated formulæ, we are led to the conclusion that there is just a little tension in the molecules of aromatic hydrocarbons, less than that produced by one C : C link. Probably this has been best expressed up to the present time by Baeyer's centric formula, although this is not altogether satisfactory.

The Polytechnic, Regent Street, W.

Quantitative Determination of Hydroxyl Groups by means of Magnesium Organic Compounds.—Th. Zerewitinoff.—The author describes an apparatus in which magnesium-methyl iodide can be used to determine hydroxyl quantitatively. He recommends the use of pyridine as solvent and measures directly the volume of methane generated. This method can be applied not only to alcohols and phenols of simple constitution, but also to compounds of complicated structure, such as sugars, acids, oximes, &c. The method is quite accurate enough to leave no doubt about the number of hydroxyls present in the compound investigated. It is quickly carried out at the ordinary temperature, and is very simple, while the possibility of secondary reactions is practically excluded.—*Berichte*, xl., No. 8.

A SYSTEM OF QUALITATIVE ANALYSIS FOR THE COMMON ELEMENTS.*

Part II.—Analysis of the Silver, Copper, and Tin Groups.

By ARTHUR A. NOYES and WILLIAM C. BRAY.

(Concluded from p. 296).

Confirmatory Experiments and References (*contd.*).

Analysis of the Tin Group.

P. 41, N. 1 : *Detection of the Tin Group by the appearance of the* HCl *Precipitate from the Ammonium Polysulphide Solution.*—Separate 10 cc. portions of the ammonium polysulphide reagent (see P. 41, N. 2) were diluted to known volumes in some experiments with hot water, and in others with cold water ; the solutions were then made acid by adding HCl slowly, and the mixtures were shaken and allowed to stand ; from cold solutions of a total volume of 30 to 50 cc. the sulphur separated as a pure white, finely divided precipitate, which coagulated slowly on shaking, and had then only a faint yellow tinge which did not change on warming. From more concentrated solutions, and especially from hot solutions, the yellow colour after coagulation was more pronounced. Separate 10 cc. portions of the ammonium polysulphide reagent containing 1 mgm. As were diluted with 20 cc. and with 40 cc. water ; HCl was slowly added until the solutions were acid ; the mixtures were shaken and allowed to stand ; the precipitate had at first the appearance of pure sulphur, but it coagulated more quickly, became flocculent, and turned brilliant yellow. Further experiments showed that the coagulation and change of colour took place more quickly when the mixture was slightly warmed after coagulation.

The experiment was repeated, using 1 mgrm. Sb instead of As ; the HCl precipitate remained white as long as the solution remained alkaline, but on further addition of HCl the orange colour of the Sb_2S_5 became very apparent ; the precipitate quickly coagulated and became flocculent. The experiment was repeated with 1 mgrm. Sn : the HCl precipitate had a very faint yellow tinge ; it coagulated only slowly, and appeared like the pure sulphur precipitate, except that it had a much darker yellow colour. The experiment was repeated with 1 mgrm. Cu as $CuSO_4$; a dark orange-yellow (liver-coloured) precipitate was obtained. The experiment was repeated with 1 mgrm. Hg as $HgCl_2$; the HCl precipitate was nearly white, but when warmed slightly it became dark grey in colour.

Colour of a Mixture of Tin and Antimony Sulphides.—500 mgrms. Sn as $SnCl_2$ and 200 mgms. Sb as $SbCl_3$ were slowly added to 10 cc. of a warm ammonium polysulphide solution, and the clear solution obtained was at once acidified with HCl ; a brown precipitate separated, which slowly became dark grey in colour. The experiment was repeated, except that the ammonium polysulphide solution was cooled and diluted to about 40 cc. and HCl was slowly added ; the precipitate was at first yellow with an orange tint, but on standing it slowly became darker, assuming first a brown and finally a dark grey colour. These precipitates were treated by P. 42—47 ; the antimony and tin dissolved completely in HCl (1·20) (P. 42), and the antimony was completely precipitated in P. 45 as an orange precipitate.

P. 41, N. 2 : *Solubility of Tin-group Sulphides in* NH_4OH.—See C. E., P. 22, N. 1.

For evidence that salts of intermediate sulpho-oxyacids of arsenic are formed when As_2S_5 is dissolved in an alkali, see McCay (*Ber.*, 1899, xxxii., 2471 ; *Zeit. Anorg. Chem.*, 1901, xxv., 459) ; McLouchlan (*Ber.*, 1901, xxxiv., 2166) ; Weinland and Lehman (*Zeit. Anorg. Chem.*, 1901, xxvi., 322). Treadwell ("Qual Anal.", p. 188, 1902) concludes that K_3SbO_3 is not formed by the action of KOH on Sb_2S_3 according to the equation $Sb_2S_3 + 6KOH = K_3SbO_3 + K_3SbS_3 + 3H_2O$, because this solution is stable when diluted, while a solution of K_3SbO_3 is not.

For evidence that the precipitation of arsenic is incomplete when a solution of As_2S_5 in an alkali is made acid, see Weinland and Lehman, *loc. cit.*, and Vanino and Griebel, *Zeit. Anal. Chem.* 1901, xl., 589.

Presence of Copper and Mercury in the Tin Group.—For the solubility of CuS and HgS in NH_4OH and in ammonium mono- and polysulphide, see C. E., P. 22, N. 4. For the fact that copper and mercury will divide in the heating with HCl (1·20), see C. E., P. 42, N. 6. That the presence of even 2 mgrms. Cu or of Hg does not interfere with the detection of arsenic is shown in C. E., P. 43, N. 3. That the same amount of copper or mercury does not prevent the detection of antimony is shown in C. E., P. 46, N. 1.

P. 42, N. 1 : *Solubility of* Sb_2S_5 *in* HCl (1·20).—500 mgrms. Sb as sulphide, freshly precipitated from an ammonium polysulphide solution, and therefore consisting mainly of Sb_2S_5, were treated according to the procedure ; nearly all the antimony dissolved, but the sulphur residue had an orange-red colour. The residue was treated a second time in the same way, and the HCl solution diluted and saturated with H_2S ; a small precipitate of Sb_2S_3 estimated to contain 1 or 2 mgrms. Sb formed. The sulphur residue was again treated with HCl ; scarcely any Sb dissolved, although the residue still had a distinct orange colour.

A mixture of 1 mgrm. Sb as Sb_2S_5 with 500 mgrms. As as As_2S_5 (freshly precipitated from an ammonium polysulphide solution, and carefully dried by suction) was treated by the procedure, and the residue subjected to a second and then to a third treatment ; the separate HCl solutions were diluted and treated with H_2S by P. 45 ; the first solution contained about 0·6 mgrm. Sb, the second about half this amount, and the third only a trace. This experiment was repeated, except that the sulphides were not carefully dried before adding HCl (1·20) ; the second HCl solution contained more Sb than the first, thus showing that the presence of water interferes with the action of the HCl.

Formation of $SbCl_3$ *by Dissolving* Sb_2S_5 *in* HCl.—See Classen and Bauer (*Ber.*, 1883, xvi., 1067).

P. 42, N. 2 : *Solubility of* As_2S_5 *in* HCl (1·20).—Seven different 500 mgrm. portions of As as As_2S_5, freshly precipitated from an ammonium polysulphide solution, were treated by the procedure, and the filtrates were warmed and saturated completely with H_2S ; only a faint precipitate resulted, in no case corresponding to more than a small fraction of a mgrm. of arsenic. The experiment was repeated, except that the HCl (1·20) was boiled gently for five minutes ; the filtrate was found to contain 5 to 10 mgrms. As. The vapours given off blackened lead acetate paper held above the flask.

P. 42, N. 3 : *Solubility of* As_2S_3 *in* HCl (1·20).—Six separate 500 mgrm. portions of As as As_2S_3, freshly precipitated from H_3AsO_3 solution by H_2S in five of the experiments and by acidifying a solution of As_2S_3 in NH_4OH in the remaining one, were treated by the procedure, and the filtrate saturated with H_2S ; in each experiment distinct precipitates of As_2S_3 were obtained, which were estimated to contain between 1 and 5 mgrms. As. The experiments were repeated, except that a slow current of H_2S was passed through the HCl during the experiment ; the filtrates then gave with H_2S scarcely any precipitate. A solution of 100 mgrms. As as As_2O_3 in 20 cc. HCl (1·20) was saturated with H_2S for five minutes at about 90°, the solution decanted off, water added, and H_2S again passed in ; no more precipitate separated.

P. 42, N. 6 : *Solubility of* CuS *and* HgS *in* HCl.—Ten mgrms. Cu as CuS and 10 mgrms. Hg as HgS, freshly precipitated were treated in separate experiments by P. 42 ; the greater part, but not all, of each of the precipitates was dissolved.

**Solubility of* TeS_2 *in* HCl (1·20).—Fifty mgrms. Te as

* From the *Technology Quarterly*, xix., No. 3, September, 1906.

TeO_2 dissolved in HCl were added to 10 cc. ammonium polysulphide; the solution was treated by P. 41, the black HCl precipitate was heated with HCl (1·20) by P. 42, and the filtrate was saturated with H_2S; a precipitate formed estimated to contain about 1 to 2 mgrms. Te. The experiment was repeated, except that the HCl solution was kept saturated with H_2S; in this case no tellurium dissolved.

**Insolubility of Sulphides of* Pt, Au, Se, *and* Mo *in* HCl (1·20).—Twenty mgrms. Pt, 10 mgrms. Au, 50 mgrms. Se, and 50 mgrms. Mo, all as sulphides precipitated by acidifying an ammonium polysulphide solution, were in separate experiments digested at about 90° for ten minutes with 10 cc. HCl (1·20), diluted, and filtered, as described in P. 42; the filtrates were saturated with H_2S at 100°, diluted to 50 cc., again heated, and saturated with H_2S; no precipitate separated in any case, not even after several minutes, thus showing that nothing had dissolved in the HCl.

P. 43, N. 1: *Reactions between* $HClO_3$ *and* HCl.—See Schacherl (*Liebig's Ann. Chim.*, 1876, clxxxii., 193); Bray (*Zeit. Anorg. Chem.*, 1906, xlviii., 242).

P. 43, N. 2: *Non-existence of* $AsCl_5$.—See Smith and Hora (*Journ. Am. Chem. Soc.*, 1904, xxvi., 632). For earlier references, see Baskerville and Bennet (*Journ. Am. Chem. Soc.*, 1902, xxiv., 1070).

Non-volatility of Arsenic Acid from HCl *Solution.*—2·0 grms. As as As_2O_5, containing a small amount of As_2O_3, were dissolved in 20 cc. HCl (1·20), and distilled until only half the volume remained in the flask; 10 cc. more of HCl (1·20) were added, and the solution distilled as before; and this operation was repeated several times; the distillates were collected in separate portions of cold water, and saturated with H_2S; in the first distillates yellow precipitates appeared at once, which decreased in amount from about 15 mgrms. As in the first distillate to about 0·5 mgrm. As in the fifth. (This was evidently due to the As_2O_3 present as impurity). These solutions were filtered, and the filtrates treated at 90° with H_2S for several minutes; very little, if any, precipitate was obtained, showing that arsenic in the higher state of oxidation was practically absent. From later distillates precipitates containing about 0·5 mgrm. As separated quickly with H_2S in the cold, and no further precipitate separated when the solutions were heated and treated with H_2S. Thus, even from this concentrated solution of arsenic acid in the presence of concentrated HCl only a trifling amount of arsenic volatilised. Since the higher halogen compound of an element is in general more volatile than the lower, it is therefore highly probable, from the above result, that $AsCl_5$ is not present even in concentrated HCl solution.

P. 43, N. 3: *Non-Influence of Mercury, Antimony, or Tin on the Test for Arsenic with* $MgCl_2$.—Two mgrms. Hg as $HgCl_2$, 2 mgrms. Sn as $SnCl_4$, 2 mgrms. Sb as Sb_2S_3 were treated in separated experiments according to the procedure; with mercury a precipitate was obtained with NH_4OH, and the filtrate when acidified with HCl and treated with H_2S gave no precipitate; with tin and antimony no permanent precipitate formed in the NH_4OH solution, nor was one formed with $MgCl_2$ and NH_4Cl.

P. 43, N. 4: *Delicacy of Test for Arsenic.*—0·5, 1, and 2 mgrms. As as H_3AsO_4 were treated in separate experiments according to P. 43, the final volume being in each case about 5 cc.; with 2 mgrms. the $MgNH_4AsO_4$ precipitate appeared immediately upon shaking; with 1 mgrm., after gentle stirring; and with 0·5 mgrm., slowly after rubbing with a glass rod for a minute or two.

*P. 43*a*, N. 2: *Action of* KI *on* K_2PtCl_6.—To 5 mgrms. Pt as H_2PtCl_6 were added 10 cc. water and a few drops KI solution; a deep red solution resulted. Five cc. CS_2 were added, and the mixture shaken; the water layer remained dark red, and the CS_2 solution was coloured slightly, owing to the presence of a trace of iodine. The water layer was shaken with a fresh portion of CS_2; this time the CS_2 layer was colourless, thus proving that only an insignificant quantity of iodine was present, and therefore that the platinic compound is not reduced. To the solution some H_2SO_3 solution was added; the colour of the solution changed at once to a pale yellow.

*P. 43*b*, N. 1: *Action of Oxalic Acid on Solutions of Chlorauric, Selenous, Tellurous, and Molybdic Acids.*—Two mgrms. Au as $AuCl_3$ were dissolved in one experiment in a dilute HCl solution containing about 0·5 grm. $H_2C_2O_4$, in a second one in a dilute solution of NH_4OH and $(NH_4)_2C_2O_4$, and the solutions were evaporated to 3 to 4 cc.; no precipitate separated in either case. The solutions were then evaporated almost to dryness to expel the excess of HCl and of NH_4OH, were diluted to about 15 cc., and again boiled; a purple precipitate of gold quickly appeared in both cases. In another experiment 0·5 mgrm. Au as $AuCl_3$ was added to 10 cc. of a dilute $(NH_4)_2C_2O_4$ solution which had been made slightly acid with $H_2C_2O_4$, and the solution was heated to boiling; a purple precipitate of gold separated.

Five mgrms. Au as $AuCl_3$ were treated according to the procedure; a precipitate of gold appeared quickly, and continued to separate for two or three minutes. After about five minutes the gold was filtered off, and the filtrate again digested for several minutes on the steam-bath; no further precipitate of gold separated.

Fifty mgrms. Se as H_2SeO_3, 50 mgrms. Te as H_2TeO_3, and 50 mgrms. Mo as $(NH_4)_2MoO_4$ were treated in separate experiments by *P. 43*b*; in the case of tellurium a white precipitate separated from the $H_2C_2O_4$ solution on evaporation, but it dissolved readily on adding HCl; in the other two experiments no precipitate formed, and no colour change was noticed.

*P. 43*c*, N. 1: *Action of* H_2SO_3 *on* H_2SeO_3.—One mgrm. Se as SeO_2 in 10 cc. HCl (1·15) was saturated with SO_2 gas at room temperature; a red precipitate appeared at once, and continued to increase slowly. After five minutes the solution was filtered, and the filtrate allowed to stand; it remained clear. The experiment was repeated, except that the solution was saturated at 90°; a reddish precipitate appeared at once, but it changed rapidly to a very compact nearly black precipitate that collected at the bottom of the test-tube. The first experiment was repeated with 0·5 mgrm. Se; a considerable red precipitate separated within five minutes.

*P. 43*c*, N. 2: *Action of* H_2SO_3 *on* H_2TeO_3.—100 mgrms. Te as TeO_2 were dissolved in separate experiments in 10 cc. HCl (1·20), in 10 cc. HCl (1·20), and 5 cc. water, and in 20 cc. HCl (1·12). Each solution in a test-tube was saturated with SO_2 gas, was allowed to stand five minutes, and then placed in a steam-bath at 100° for fifteen minutes; no precipitate of tellurium was formed in any case. Enough water was added to make the volume 30 to 40 cc.; a black precipitate of tellurium appeared at once.

In each of eight test-tubes were placed 0·5 mgrm. Te as TeO_2 and 25 cc. saturated H_2SO_3 solution. To the first of these were added 3 cc. 40 per cent HCl, to the second 4 cc., to the third 5 cc., and so on up to the eighth, which contained 10 cc.; the tubes were then all heated in a steam-bath; those with 3 and 4 cc. HCl gave scarcely any precipitate; in the others the quantity of precipitate increased with the increase of acid up to 7 cc., and then decreased steadily with further increase in the amount of HCl.

*P. 43*d*, N. 1: *Action of* KI *and of* KI + H_2SO_3 *on Tellurium Solutions.*—For the formation of TeI_4 in the reaction between H_2TeO_3 and KI, see Gooch and Morgan (*Am. Journ. Sci.*, 1896, [4], ii., 271). For the formation of K_2TeI_6, see Wheeler (*Am. Journ. Sci.*, 1893, [3], xlv., 267). For its deep red colour, see Norris and Fay (*Am. Chem. Journ.*, 1900, xxiii., 109).

To prove that tellurium itself and not an iodide of it is precipitated by H_2SO_3 and HI, 20 mgrms. Te as TeO_2 were dissolved in 10 cc. HCl (1·12) and 1 mgrm. I as KI, and a little solid Na_2SO_3 were added; a large black precipitate formed slowly. This was filtered off after half-an-hour, the filtrate was diluted to 20 cc., and to it were added a few drops KI solution and a little solid Na_2SO_3; a black precipitate estimated to contain only 1 to 2 mgrms. Te

resulted. The experiment was repeated, except that the mixture was allowed to stand over night before filtering; only about 0·2 mgrm. Te remained in solution.

To determine the proper concentration of HCl for the complete precipitation of the tellurium, a few drops of KI solution were added to solutions containing 0·5 mgrm. Te as TeO_2 dissolved in 10 cc. HCl (1·20), in 15 cc. HCl (1·15), in 20 cc. HCl (1·12), and in 30 cc. HCl (1·06), respectively; a deep red colour resulted in each case, but was less intense in the most concentrated and in the most dilute HCl than in the other two solutions. A crystal of Na_2SO_3 was added to each solution; no change was observed in the three more concentrated HCl solutions, but a black precipitate of tellurium formed in the most dilute solution. In another experiment 0·1 mgrm. Te was dissolved in 20 cc. HCl (1·06), and a drop of KI and a crystal of Na_2SO_3 added; a black precipitate resulted.

Fifty mgrms. Te as TeO_2 were treated according to the procedure, and the precipitated tellurium filtered off after five minutes; the filtrate had a strong odour of SO_2, but no more tellurium separated in half-an-hour, even when a little KI was added.

*P. 43*d*, N. 2: *Action of* HI *on* H_2SeO_3.—See Norris and Fay (*Am. Chem. Journ.*, 1900, xxiii., 109).

*P. 43*d*, N. 3: *Action of* HI *on* H_2MoO_4.—To separate solutions of 50 mgrms. Mo as MoO_3 in 10 cc. HCl (1·20) and in 20 cc. HCl (1·12) a few drops of KI solution were added; iodine was slowly liberated in both cases, but more rapidly in the more strongly acid solution.

*P. 43*e*, N. 2: *Action of Zinc and* KCNS *on* H_2MoO_4.—To 1 mgrm. Mo as MoO_3 dissolved in 20 cc. HCl (1·06) in a test-tube were added a crystal of KCNS and some granules of zinc; a brilliant red colour appeared very quickly, and remained unchanged for about five minutes; the colour slowly changed to yellow, and then faded until after about half-an-hour the solution was nearly colourless. The experiment was repeated, except that the KCNS was not added until after the action of the zinc had continued for fifteen minutes; a yellow colour resulted. The experiment was repeated, except that the KCNS was added after about an hour; the solution remained colourless.

For the composition of the red compound produced with KSCN and zinc, see Sand and Burger (*Ber.*, 1905, xxxviii., 3384; 1906, xxxix., 1761).

P. 44, N. 1 and 2: *Action of* H_2S *on* H_3AsO_4 *Solutions.*—See McCay (*Am. Chem. Journ.*, 1888, x., 459). Brauner and Tomicek (*Journ. Chem. Soc.*, 1888, liii., 145). Usher and Travers (*Journ. Chem. Soc.*, 1905, lxxxvii., 1370).

P. 45, N. 1: *Separation of Antimony and Tin by* H_2S.—Known amounts of Sb and Sn as chlorides were added to an ammonium polysulphide solution, and precipitated as Sb_2S_5 and SnS_2 with HCl; the precipitates were dried by suction, and digested with 10 cc. HCl (1·20) at 90° for ten minutes in a 50 cc. conical flask. Each solution so obtained was diluted to a known volume, and treated with H_2S just below the boiling-point. The volume of the diluted solution at which the precipitation of Sb_2S_3 was nearly or quite complete, and that at which the precipitation of SnS_2 began, and became considerable are given in the following table:—

Experiment No.	Sn.	Sb.	Volume of solution at which precipitation of antimony was—		Volume of solution at which precipitation of tin—	
			Nearly complete.	Complete.	Began.	Was considerable
	Mgrms.	Mgrms.				
1	500	0	..	..	50	60
2	500	0	..	..	60	70
3	400	1	40	50	60	70
4	500	1	..	50	60	70
5	500	1	..	55	60	70
6, 7	500	200	40	50	60	70
8	10	500	40	50	..	..
9	200	200	..	50	..	..
10	0	1	..	55	..	..

In Experiment No. 1 a slight yellow precipitate of SnS_2 appeared in testing for antimony, but a good blank was obtained in No. 2. In Experiment 4 an orange-red precipitate of Sb_2S_3 was obtained; in Experiment 5 a dark coloured precipitate, which gave a good confirmatory test for antimony. In Experiment 10 the Sb_2S_3 precipitate did not separate until the last 5 cc. of water were added.

P. 45, N. 2: *Precipitation of* CuS *and* HgS *from* HCl *Solution.*—One mgrm. Cu and 0·5 mgrm. and 4 to 5 mgrms. Hg as chlorides were added in separate experiments to 10 cc. HCl (1·20) and 40 cc. H_2O, and the solutions were heated to boiling, and saturated with H_2S at 90°; in the first two cases light grey precipitates formed slowly, which on the filter appeared to be black; in the last case a black precipitate. The precipitates were filtered out, the solutions diluted and treated with H_2S; in the mercury experiments they gave no precipitates, but in the case of Cu a very slight precipitate formed.

P. 46, N. 1: *Influence of Copper and Mercury on the Reduction Test for Antimony.*—One and 2 mgrms. Hg as HgS, and 1 and 2 mgrms. Cu as CuS were treated in separate experiments according to P. 46; the mercury separated on the platinum as a grey loosely adhering film, the copper as a red metallic, firmly adhering deposit, which could not be mistaken for antimony.

The experiments were repeated in the presence of 0·5 and 1 mgrm. Sb; characteristic black deposits of Sb were obtained.

P. 46, N. 2: *Behaviour of Arsenic and Tellurium in the Reduction Test for Antimony.*—One, 4, and 10 mgrms. As as H_3AsO_4, and 0·5 mgrm. Te as H_2TeO_3 were treated in separate experiments according to P. 46; with the 10 mgrms. As and with the tellurium black deposits on the platinum were obtained, which dissolved readily in a normal cold alkaline solution of NaOCl; no deposit of arsenic was obtained with the 1 or 4 mgrms. As. It is therefore improbable that a black deposit of arsenic will ever be obtained in an actual analysis, since only very small amounts will be dissolved in the HCl treatment (P. 42).

Insolubility of Sb *in* NaOCl.—One mgrm. Sb precipitated on platinum-foil by the action of HCl and Sn was treated in the cold for five to ten minutes with a normal alkaline NaOCl solution; no change took place.

P. 47, N. 1: *Effect of Temperature on the Precipitation of* SnS_2.—A solution of 1 mgrm. Sn as $SnCl_4$ in 10 cc. HCl (1·20) was successively diluted with portions of water, and saturated with H_2S at 90° after each dilution; a precipitate formed only when the volume of the solution had become 110 to 120 cc. The experiment was repeated several times, except that the solutions were saturated for 5 to 10 minutes with H_2S at 20°; a precipitate formed when the volume became 60 to 70 cc.

P. 47, N. 2: *Delicacy of Confirmatory Test for Tin.*—0·5 Sn as $SnCl_4$ was treated in several experiments according to P. 47; in all cases a precipitate of SnS_2, and in most cases one of Hg_2Cl_2, was obtained.

Tetramethyl Dioxyacetone.—Louis Henry.—When ethyl mesoxalate acts on magnesium methyl bromide in ethereal solution in the proportion of one molecule of the former to five of the latter compound, the product of the reaction is a white substance crystallising in needles. It is insoluble in water, easily soluble in alcohol and ether, melts at 117—118°, and boils without decomposition at 238—240° under ordinary pressure. This substance is found by analysis and by the cryoscopic determinations of the molecular weight to be tetramethyl dioxyacetone, $(CH_3)_2=C(OH)-CO-C(OH)=(CH_3)_2$. It is noteworthy that, in spite of the presence of sufficient organo-metallic substance, the ketonic group, $>CO$, is not attacked. The melting- and boiling-points of this compound agree with those which would be assigned to it *à priori* if the effect of the intercalation of the ketone group were calculated.—*Comptes Rendus*, cxliv., No. 22.

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Ordinary Meeting, June 6th, 1907.

Sir WILLIAM RAMSAY, K.C.B., F.R.S., President, in the Chair.

MESSRS. A. T. Cameron, G. Fowles, S. W. Smith, and J. W. Yates were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Frank Buckney, B.A., 51, Highbury Park, N.; William Hay, Holton House, Beverley Road, Hull; George Joseph Saunders, B.E., School of Mines, Charters Towers, Queensland, Australia; David Willott, B.Sc., Rosedale, Thorncroft Road, Sutton, Surrey; Hubert Arthur Wootton, B.A., B.Sc., 20, Great College Street, Westminster, S.W.

Of the following papers, those marked * were read:—

*117. "*The Relation between Absorption Spectra and Chemical Constitution.* Part VII. *Pyridine and some of its Derivatives.*" By FRANK BAKER and EDWARD CHARLES CYRIL BALY.

The authors have made a spectroscopic examination of pyridine and its substitution products, with the object of determining the influence of the nitrogen atom and also the constitution of the pyridones. It was shown how the nitrogen atom tends to restrain the motions of the ring, this restraint being very much lessened by the addition of acid to the solutions. A very similar effect is produced by the substitution by chlorine, inasmuch as the basicity of the nitrogen is thereby considerably reduced.

In the case of the oxypyridines, the α- and δ-compounds were shown to be true pyridones, whilst the β-isomeride possesses the hydroxylic configuration.

*118. "*The Interaction of Methylene Chloride and the Sodium Derivative of Ethyl Malonate.*" By FRANK TUTIN.

The reaction which takes place when methylene chloride is heated with an alcoholic solution of the sodium derivative of ethyl malonate has been studied, and the following three crystalline by-products resulting from the condensation were examined.

1. A sodium salt crystallising from alcohol in yellow leaflets.

2. An *acid* crystallising in needles, which melt at 132°.

3. An *acid* obtained in small needles, which are insoluble, or nearly so, in all solvents.

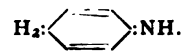
The yellow sodium salt was obtained by Perkin and Prentice (*Trans.*, 1891, lix., 991), but was not further examined by them. It has the formula $C_{15}H_{21}O_8Na$, and yields a liquid *acid*, $C_{14}H_{21}O_6{\cdot}CO_2H$, which gives a violet coloration with ferric chloride. On hydrolysis, this acid first gives an *acid* melting at 305°, but when completely hydrolysed, yields a *tetracarboxylic acid*, $C_6H_8(CO_2H)_4$ (m. p. 138—139°). The latter compound, although melting at the same temperature as *cis-cyclo*hexane-1:2:4:5-tetracarboxylic acid, is not identical with it.

The substance melting at 132° possesses the formula $C_{18}H_{24}O_6(CO_2H)_2$, and, on hydrolysis, yields an *acid* melting at 306°.

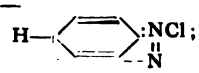
The insoluble substance is hydrolysed by sodium carbonate, giving a *sodium* salt, $C_{32}H_{35}O_{20}Na_3{,}6H_2O$, crystallising in white needles; the corresponding *potassium* salt is insoluble and anhydrous. The *acid*, $C_{29}H_{35}O_{14}(CO_2H)_3$, obtained from these salts crystallises in leaflets melting at 200°.

*119. "*The Constitution of the Diazo-compounds.*" By JOHN CANNELL CAIN.

None of the formulæ hitherto proposed for the diazo-salts can account for the great ease with which such compounds lose their diazo-nitrogen. Nitrogen attached to the benzene ring, as, for example, in the case of aniline, is readily eliminated only by oxidation, and Ostrogowich and Silbermann have recently shown that in this process aniline probably assumes the tautomeric form—



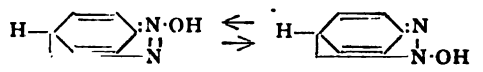
As the diazotisation process closely resembles this reaction the author proposed for diazobenzene salts (chloride) the quinonoid formula—



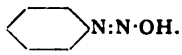
this bears much analogy to the formula of quinonechloroimide, which also loses nitrogen on boiling with water.

The new formula explains why, in compounds where the atom in the para-position to the amino-group is already saturated, no diazo-salt can be formed; thus, for example, *ac*-tetrahydronaphthylamine and 4-aminoquinoline yield no diazo-salts. For a similar reason no aliphatic diazo-chlorides are known.

The corresponding formula for the diazohydroxide may, unlike the chloride, give rise to two tautomeric forms:—



the latter of which represents the constitution of the normal or *syn*-diazo-compounds, and is closely related to the formula for the *iso*- or *anti*-compounds:—



As these formulæ fully explain the reactions of the diazo-compounds the stereo-chemical theory is rendered unnecessary.

The following recommendations as to nomenclature were suggested:—

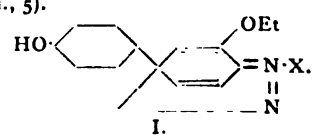
i. The word "diazonium" should be retained for the diazo-salts.

ii. The normal or *syn*-metallic diazo-compounds should be called normal diazo-oxides or diazo-oxides.

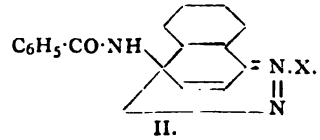
iii. The *iso*- or *anti*-compounds should be called *iso*-diazo-oxides.

DISCUSSION.

Dr. MORGAN said that the retention of the quinquivalency of the salt forming nitrogen atom, and the representation of the mobility of the diazo-group N_2 by means of the doubly linked attachment to the aromatic nucleus, were both strong arguments in favour of the new formula for diazonium salts. It must, however, not be forgotten that other types of diazo-derivatives, the diazoamines and the acyl-*p*-diazoimides, for example, also readily give up their diazo-nitrogen, and it still remained to be seen whether this formulation could be extended to those cases. The new formula represented diazonium salts as substances of a quinonoid type, but so long as the radicle in the para-position to the diazo-nitrogen was hydrogen or a simple saturated group (methyl, methoxyl, &c.) there was no development of colour; when, however, this hydrogen was replaced by a complex aromatic group then the compound exhibited colour. The stable yellow diazo-salts having the general Formula I. were a case in point (Cain, *Trans.*, 1905, lxxxvii., 5).



I.



II.

Having been engaged for some time in the investigation of compounds of this nature, he hoped, in conjunction with Mr. Wootton, to bring forward at the next meeting a complete series of coloured stable diazo-salts (Formula II.) derived from *p*-aminobenzo-α-naphthalide. A formula such as that advocated by Dr. Cain afforded a satisfactory explanation of the properties and reactions of these substances.

Dr. HEWITT drew attention to the coloured diazonium salts which had been obtained by different chemists. Some of the earliest to be isolated were those derived from *p*-semidine bases; these were not merely coloured, but Jacobson found that they were remarkably stable to heat. The diazonium salts prepared by Dr. Cain and Dr. Morgan were coloured and stable, and like Jacobson's compounds could be represented with a true quinonoid structure.

Dr. LAPWORTH pointed out that if, as this ingenious formulation indicated, one of the nitrogen atoms in the diazo-group was attached to the carbon atom in the para-position to that linked to the other nitrogen atom, it had to be assumed that the new carbon-nitrogen linking was very much more unstable than that which represented the normal link between the diazo-group and the benzene nucleus. Yet the former was represented as a single bond, whilst a double one was assumed in the latter case to account for its instability. Had Dr. Cain any explanation of the fact that during the changes of diazo-compounds nitrogen had never been found at the point where his formula suggested it should, at least occasionally, be discovered?

Dr. CAIN, in reply to Dr. Lapworth, pointed out that the linking in the group N·CH was usually a very unstable one, and in the present case was largely influenced by the condition of the linkings in the benzene nucleus.

*120. "*Dibromoaminoazobenzene.*" By JOHN THEODORE HEWITT and NORMAN WALKER.

A dibromoaminoazobenzene, produced by the action of bromine on an aqueous alcoholic solution of aminoazobenzene, has been described by Berju (*Ber.*, 1884, xvii., 1403), who gives the melting-point as 152°, and has not determined the constitution of the compound. The present authors find that the action of bromine on an acetic acid solution of aminoazobenzene in presence of sodium acetate gives benzeneazo-*oo*-dibromoaniline, m. p. 168°. This forms the chief constituent of the product obtained by Berju's method. The *diacetyl* derivative melts at 137°, the *dibenzoyl* derivative at 229°. The constitution was determined by reduction with sodium hyposulphite, the 2 : 6-dibromo-1 : 4-phenylenediamine of m. p. 138° (E. Noelting, E. Grandmougin, and O. Michel, *Ber.*, 1892, xxv., 3334) being isolated.

121. "*Phenol* p-*Sulphoxide.*" By SAMUEL SMILES and ALEXANDER WILLIAM BAIN.

The authors described the preparation of *phenol* p-*sulphoxide*, and showed that its properties differ widely from those assigned by Schall and Uhl (*Ber.*, 1892, xxv., 1893) to the substance obtained by the action of fused alkali hydroxide on the dye-stuff rubbadin, and to which they attributed the same constitution. The condensation of phenol *p*-sulphoxide with salicylic acid yields *di*-p-*hydroxyphenylsalicylthetine.*

122. "p-*Cresol Sulphoxide and Sulphide.*" By SAMUEL SMILES and THOMAS PERCY HILDITCH.

These substances were obtained during an investigation of the action of dehydrating agents on ortho-hydroxysulphoxides. p-*Cresol sulphoxide* is formed by the interaction of *p*-cresol, aluminium chloride, and thionyl chloride. It crystallises in needles, which melt at 191°, and are soluble in alcohol or hot water; it dissolves in strong sulphuric acid with a deep blue colour, but, unlike the other hydroxysulphoxides which have been prepared, this colour is not discharged by the addition of a phenolic ether (Smiles and Le Rossignol, *Trans.*, 1906, lxxxix., 701). When the blue solution is mixed with water a pink solid is precipitated. The same substance was obtained by boiling the sulphoxide with phosphoryl chloride; it is soluble in aqueous alkali hydroxide, and the yellow solution on shaking with benzoyl chloride yields a colourless benzoyl derivative. The substance also furnishes a platinichloride. On account of the amorphous character of these compounds the investigation has been abandoned.

Dibenzoyl-p-*cresol sulphoxide* melts at 173°.

p-*Cresol sulphide* was prepared by reduction of the sulphoxide; it crystallises from a mixture of acetic acid and water in colourless needles, which melt at 101—103°.

123. "*Molecular Weight of β-Naphthol in Solution in Solid Naphthalene.*" By EDGAR PHILIP PERMAN and JOHN HUGHES DAVIES.

The vapour pressures of solid naphthalene, of β-naphthol, and of isomorphous mixtures of these substances, at 70°, were estimated by aspirating a known volume of air through a glass spiral containing the solid, and determining the loss of weight. The mean vapour pressures obtained were:—Naphthalene, 3·751 mm. of mercury; β-naphthol, 0·1134 mm.; solid solution of five parts of β-naphthol to 100 parts of naphthalene, 3·592 mm.; ten parts to 100, 3·476 mm.; fifteen parts to 100, 3·380 mm. The corresponding molecular weights calculated are 151, 175, and 194 respectively. It is concluded that in dilute solutions, β-naphthol has the same molecular weight as in the gaseous state, whilst it associates in more concentrated solutions.

124. "*Synthesis of Hexatriene Derivatives.*" (Preliminary Note). By IDA SMEDLEY.

Experiments undertaken with the object of preparing a series of hexatriene derivatives by the elimination of chlorine from αα-dichloro-γ-alkyl-propylenes having led to unsuccessful results (*Proc.*, 1906, xxii., 158), the method adopted by Van Romburgh and Dorssen (*Proc. K. Akad. Wetensch. Amsterdam*, 1905, viii., 565) for the preparation of the simplest member of the series, C_6H_8, was applied. The formate of dihydrocinnamoin was prepared; this readily resinifies, and does not therefore afford a convenient method of synthesis of the pure diphenylhexatriene, $C_6H_5{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}C_6H_5$.

This hydrocarbon may, however, be obtained by the condensation of phenyl*iso*crotonic acid with cinnamaldehyde in the presence of acetic anhydride. From acetone or benzene solution, it is deposited in pale yellow crystals, melting at 194°. The dilute benzene solution exhibits a remarkable blue fluorescence.

125. "*The Reduction of Aromatic Nitro-compounds to Azoxy-derivatives in Acid Solution.*" By BERNHARD FLURSCHEIM and THEODOR SIMON.

According to a general rule, azo- and azoxy-compounds are formed when aromatic nitro-compounds are reduced in alkaline solution, but never in presence of free mineral acids. One of the authors has, however, previously shown (*Journ. Prakt. Chem.*, 1905, [ii.], lxxi., 497) that it is often possible to isolate the azoxy-compound in acid solution as well, sometimes even in theoretical yield, and that the above mentioned law must be abandoned.

It was, however, further necessary to determine the conditions which favour the formation of azoxy-products or prevent it. To render this possible, an exact separation of the substances, resulting from the reduction of nitro-compounds by means of stannous chloride and hydrochloric acid in alcoholic solution, had to be effected. To this end the first part of the present research has been devoted, and the authors have succeeded in separating quantitatively the products of reduction, namely, amines, aminophenols, azoxy- and aminoazoxy-compounds from each other and from the unattacked nitro-compounds.

With the help of these new methods, more than sixty reductions have been carried out, with varying quantities of acid, and under changing conditions. The following nitro-compounds have been used:—Nitrobenzene, *m*-dinitrobenzene, 2 : 4-dinitrotoluene, 4 : 6-dinitro-*m*-xylene, 1-chloro-2 : 4-dinitrobenzene, 1-bromo-2 : 4-dinitrobenzene, 3 : 5-dichloro-4-bromonitrobenzene, 2 : 4-dinitrodiphenyl, amine, and *p*-nitrobenzaldehyde. The chief results may thus be briefly summarised:—

1. Reduction in acid, neutral, and alkaline solutions proceeds in accordance with Haber's hypothesis, nitroso- and hydroxylamino-derivatives being successively formed.

2. The formation of azoxy-compounds during reduction is due to a condensation of hydroxylamino- and nitroso-derivatives.

3. This condensation can only take place when the residual affinity of the tervalent nitrogen atom in the hydroxylamino-compound is not saturated.

4. Such saturation taking place, when salts are formed anything favouring dissociation of these salts, for instance, negative substituents in the nucleus, also favours condensation, whilst increasing quantities of acid tend to prevent it.

5. A diminution in the velocity of reduction favours condensation.

6. Ortho-substituents diminish the velocity both of reduction and condensation; these being opposite influences, the influence of ortho-substituents on the formation of azoxy-compounds varies with their nature, some favouring condensation (bromine, &c.), others tending to prevent it (methyl, &c.).

All the results can be depicted graphically, the percentage of azoxy-compounds produced forming for each substance a curve falling with increasing quantities of acid used. In the absence of ortho-substitution, nitro-compounds with strongly negative nucleus substituents yield curves running above those obtained with less negative radicles.

126. "*Action of Selenium and Tellurium on Arsine and Stibine.*" By FRANCIS JONES.

In continuance of his previous work (*Journ. Chem. Soc.*, 1876, 641), where it was shown that sulphur decomposes arsine and stibine in presence of light in accordance with the equation $2SbH_3+6S = Sb_2S_3+3H_2S$, the author has now investigated the action of these hydrides on the elements analogous to sulphur, namely, selenium and tellurium, in presence and absence of light, and at 100°.

The results are shown in the following table:—

Element.	Hydride.	Result.
	a. *In Sunlight.*	
Sulphur	SbH_3	Reacts easily
Selenium	SbH_3	Reacts easily
Tellurium . ..	SbH_3	Reacts
Sulphur	AsH_3	Reacts slowly
Selenium	AsH_3	Reacts
Tellurium . ..	AsH_3	Reacts
	b. *At* 100°.	
Sulphur	SbH_3	Reacts slowly
Selenium	SbH_3	Reacts slowly
Tellurium . ..	SbH_3	Reacts very slowly
Sulphur	AsH_3	Reacts slowly
Selenium	AsH_3	No action
Tellurium . ..	AsH_3	No action
	c. *In the Dark.*	
Sulphur	SbH_3	No action
Selenium	SbH_3	Reacts slightly
Tellurium . ..	SbH_3	No action
Sulphur	AsH_3	No action
Selenium	AsH_3	No action
Tellurium . ..	AsH_3	No action

It was previously shown that the facility of the decomposition of the hydrides increases with the rise in the molecular weight of these gases, phosphine being very slowly decomposed, arsine more rapidly, and stibine very rapidly. It is now found that the action of these hydrides on sulphur, selenium, and tellurium corresponds with the rise in the atomic weights of these elements, stibine being readily decomposed by sulphur, more slowly by selenium, and still more slowly by tellurium. An exception was noticed in the case of stibine, which acts on selenium even in the dark.

In the course of the investigation it was observed that arsine reacts with solution of lead acetate, producing a black precipitate, probably an arsenide of lead, the composition of which varied in different preparations.

127. "*The Double Nitrites of Mercury and the Alkali Metals.*" By PRAFULLA CHANDRA RAY.

Mercuric nitrite forms a series of double salts with the nitrites of potassium, sodium, and lithium in which one molecule of the former combines with 1, 1½, 2, 3, and 4 molecules of the latter.

128. "*Silver-mercuroso-mercuric Hydroxynitrates and the Isomorphous Replacement of Univalent Mercury by Silver.*" By PRAFULLA CHANDRA RAY.

When a solution containing mercuroso-mercuric nitrite and silver-mercuric nitrite is allowed to evaporate spontaneously, a series of silver-mercuroso-mercuric hydroxynitrates crystallises out. In each of these salts a part of the mercurous mercury is isomorphously replaced by silver.

129. "*The Molecular Weights of Amides in Various Solvents.*" (Preliminary Note). By ANDREW NORMAN MELDRUM and WILLIAM ERNEST STEPHEN TURNER.

In the course of an investigation into the molecular condition of typical amides in various solvents, the authors have found that the molecules of trichlorolactamide, of benzanilide, and of salicylamide are associated in benzene solution even at the boiling-point, and those of benzamide in benzene, in chloroform, and in acetone solution.

No case of association in alcohol solution has been discovered, acetamide, monochloroacetamide, and benzamide giving normal results. In the case of amides derived from stronger organic acids than these, the "molecular weights" in alcohol are abnormally low.

The results obtained with water as solvent are unexpected, association being found in at least three cases, acetamide, benzamide, and salicylamide.

130. "*Some Experiments on the Oxidising Action of Hydrogen Peroxide.*" (Preliminary Note). By WILLIAM HENRY PERKIN, jun.

During the course of researches on the constitution of brazilin and hæmatoxylin, the observation was made that certain of their derivatives, when treated with hydrogen peroxide (30 per cent) and acetic acid, were readily oxidised with the formation of new substances the investigation of which will, it is hoped, throw much light on the constitutions of these important natural colouring matters.

Thus, for example, *brazilein*, $C_{16}H_9O_2(OH)_3$, is under these conditions converted into a substance, $C_{16}H_{14}O_9$, which crystallises in brown needles, and *trimethylbrazilein*, $C_{16}H_9O_2(OMe)_3$, yields a colourless crystalline substance, $C_{19}H_{20}O_8$, which melts at 218° with decomposition. The detailed description of these and other similar oxidation experiments of brazilein and hæmatein is reserved for a subsequent communication.

Experiments of a more general nature seem to indicate that hydrogen peroxide may prove to be a reagent of considerable importance, especially in connection with analytical researches.

It appears, for example, to react readily with *αα*-diketones and generally with substances possessing quinonoid structure.

Benzil is readily attacked, when its suspension in a little acetic acid is mixed with hydrogen peroxide and warmed on the water-bath, and the product contains large quantities of benzoic acid and a pale yellow oil which has not yet been investigated.

When *phenanthrenequinone* (5 grms.) suspended in glacial acetic acid (15 cc.) and hydrogen peroxide (5 cc.) is heated at 90—95°, the crystals soon dissolve, and the solution, on dilution with water, deposits 5 grms. of pure diphenic acid, a method which is by far the most convenient for the preparation of this important acid.

Aurin, under similar conditions, is very readily attacked by hydrogen peroxide with formation of *p*-hydroxybenzoic

acid and benzoquinone. Obviously the aurin is, in the first place, oxidised to *p*-hydroxybenzoic acid and quinol,—

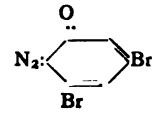
$$(C_6H_4\cdot OH)_2C:C_6H_4:O + 2H_2O_2 = = C_6H_4(OH)\cdot CO_2H + 2C_6H_4(OH)_2,$$

and the latter is then further oxidised to benzoquinone. It will be shown, in a later communication, that this decomposition is of importance in connection with the determination of the constitution of brazilein and hæmatein. The special value which appears to attach to hydrogen peroxide lies in the fact that it can be employed to oxidise phenolic substances, like brazilein and aurin, without the usual and often very laborious routine of protecting the hydroxyl groups by methylation. Experiments are in progress with the view of determining the special conditions under which hydrogen peroxide may be employed with success. The presence of acetic acid appears to be generally advantageous, but other solvents may be employed, and, in some cases, the oxidation of phenolic substances has been found to proceed well in alkaline solution.

131. "*Action of Hydroxylamine on o-Benzoquinonediazides* (*o-Diazophenols*). 3 : 5-*Dibromo-o-azoiminobenzoquinone* (4 : 6-*Dibromo-2-Hydroxyphenylazoimide*)." (Preliminary Note). By Kennedy Joseph Previté Orton, William Charles Evans, and Emrys Morgan.

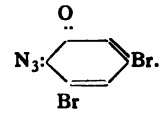
The simple means of preparing the benzoquinonediazides, especially the halogen-*o*-benzoquinonediazides from the *s*-trihalogendiazonium salts of weak acids (Orton, *Trans.*, 1903, lxxxiii., 796), a reaction in which a halogen atom is replaced by a hydroxyl group, has permitted of a detailed study of the behaviour of these substances with a number of reagents. The recent appearance of a paper by Forster and Fierz on "Aromatic Azoimides" (*Trans.*, 1907, xci., 855), in which is described the preparation of *p*-hydroxyphenylazoimide from *p*-diazophenol and hydroxylamine, shows that it is advisable to make a preliminary announcement of one of the authors' results.

3 : 5-Dibromo-*o*-benzoquinonediazide,—



(Orton, *loc. cit.*), reacts very readily with hydroxylamine in alcohol solution, the reaction being completed if the hydrogen chloride of the hydroxylamine hydrochloride is replaced by a weak acid or neutralised by a base. On adding water to the resulting alcoholic solution, the *azoimide*, the yield of which is quantitative, separates in yellowish brown needles melting at 98°, the molten material decomposing slowly a few degrees above the melting-point. The azoimide is readily soluble in all organic solvents except light petroleum, and is slightly soluble in water, to which it imparts a bright yellow colour. It has a decided acid character, dissolving in solutions of alkali hydroxides and carbonates. In anhydrous solvents, it also appears to combine directly with hydrogen chloride. The azoimide dissolves in sulphuric acid with the evolution of nitrogen, the solution acquiring a deep magenta colour. With bromine it yields a tetrabromoaminophenol.

Inasmuch as the azoimido-group does not in itself confer colour, whilst this compound is deeply coloured, the authors are inclined to give it provisionally a quinonoid structure, thus :—



3 : 5-Dibromo-2-nitro-*p*-benzoquinonediazide and 4-bromo-*o*-naphthaquinonediazide (Orton, *loc. cit.*) react similarly with hydroxylamine.

132. "*Oxime Formation and Decomposition in presence of Mineral Acids.*" By Arthur Lapworth.

The conversion of stable hydroximido-compounds into the corresponding ketones or aldehydes is, as a rule, to be effected by the use of hydrochloric acid in presence of formaldehyde. *iso*Nitrosocamphor, for example, gives an excellent yield of camphorquinonine, and even camphoroxime may be partially converted into camphor by this method, which appears to be the most general hitherto discovered. The formaldehyde is converted into formic acid in the process, while the nitrogen of the oxime appears mainly as ammonium chloride.

The hydrolytic action of mineral acids on oximes appears to be a reversible one, which is possibly, in part, the explanation of the favourable influence of the formaldehyde in the above instances. When hydroxylamine, formaldehyde, and concentrated hydrochloric acid are heated together, formic acid, ammonium chloride, and methylammonium chloride are formed. When benzaldehyde is substituted for formaldehyde, benzaldoxime, and, sometimes, benzonitrile, are formed. Camphorquinone yields camphorimide, and camphor gives campholenonitrile.

133. "*Note on the Constituents of the Seeds of the Para Rubber Tree* (Hevea brasiliensis)." By Wyndham Rowland Dunstan.

The kernels of the seeds of the Para rubber tree (*Hevea brasiliensis*) were examined at the Imperial Institute in 1902, and found to contain about 50 per cent of a fixed oil, having a specific gravity 0·9302 at 15°, saponification value 206·1, and iodine value 128·3. Like linseed oil, to which it bears considerable resemblance, this oil "dried" to a transparent varnish on exposure to air, and will probably be of commercial value for the same purposes. In the future there is likely to be an enormous production of these seeds which will not be required for planting, and their commercial utilisation is therefore a matter of importance (*Bull. Imp. Inst.*, 1903, i., 156, and 1904, ii., 22).

The seed kernels, when ground with water, evolved small quantities of hydrocyanic acid and acetone, whence it appears that a cyanogenetic glucoside is present, similar to if not identical with the phaseolunatin first obtained from the beans of *Phaseolus lunatus* (Dunstan and Henry, *Proc. Roy. Soc.*, 1903, lxxii., 285), and subsequently isolated from flax and cassava (Dunstan, Henry, and Auld, *Ibid.*, 1906, lxxviii., 145).

A mixture of enzymes was prepared from the seeds which possessed the property of hydrolysing the oil present and also olive oil. These enzymes probably include, besides a lipase-like enzyme, one capable of decomposing the cyanogenetic glucoside, since the kernels yield hydrocyanic acid by mere contact with water. The nature of the fixed oil of the cyanogenetic glucoside and of the enzymes is being fully investigated.

Van Romburgh has shown (*Ann. Jard. Bot. Buitenzorg*, 1899, xvi., 15) that the leaves of *Hevea brasiliensis* also yield hydrocyanic acid and acetone when crushed with water, and Harrison has recorded the production of hydrocyanic acid under similar conditions from the seeds of the related species *Hevea pauciflora* and *Hevea confusa* (*Rep. Govt. Lab. Brit. Guiana*, 1896-1902, Part II., p. 11).

It is hoped that sufficient material will be obtainable to enable the question to be settled as to whether these related plants, as well as *Hevea brasiliensis*, contain phaseolunatin, as seems probable.

Society of Chemical Industry.—H. M. the King has been pleased to grant a Charter of Incorporation to this Society, which was founded in 1881 to promote the application of chemical science to arts and manufactures.

NOTICES OF BOOKS.

Cyaniding Gold and Silver Ores. By H. Forbes Julian and Edgar Smart, A.M.I.C.E. Second Edition. London: Charles Griffin and Co., Ltd. 1907.

In the first edition of this treatise the authors collected from all sources information relating to the theory of the cyanide process and its practical application, and thus produced a book which for the first time gave a satisfactory survey of the whole process in all its aspects. The second edition is a no less valuable work, which managers of cyanide works who have either not the time or else lack the opportunity to refer to original publications, will find gives them sufficient information to enable them to understand thoroughly both practice and theory. All recent developments and innovations in the process are discussed with the introduction of as little mathematics as possible, and there can be no doubt that the book must rank as one of the authoritative treatises on the subject; it explains the process on a scientific basis, eliminating rule-of-thumb methods and urging the necessity of a thorough understanding of all the principles involved.

The Book of Receipts. (Beasley). Re-written by E. W. Lucas, F.I.C., F.C.S. Eleventh Edition. London: J. and A. Churchill. 1907.

This book is based upon the last reprint of Beasley's "Druggists' Receipt Book," but contains much new matter, for instance short accounts of the examination of potable waters, and the analysis of milk, &c., are now included, and many volumetric and other tables have been added. The book contains a Veterinary Materia Medica with prescriptions for the commonest ailments of animals, and a pharmaceutical formulary giving details of the preparation of many articles of domestic use and also proprietary articles. In addition, a photographic formulary gives directions for making up developing, toning, and fixing solutions, while much miscellaneous information which may be found useful by chemists, druggists, and manufacturers is included.

The Cinematograph in Science, Education, and Matters of State. By Charles Urban, F.Z.S. London: Charles Urban Trading Co., Ltd.

The object of this pamphlet is to call attention to the great value of the cinematograph as an educational instrument, which should be regarded as an indispensable possession by all well-equipped teaching institutions. The cinematograph, provided that the pictures are well chosen by experts, has not the limitations of lantern slides and is a more valuable means of imparting instruction. The Charles Urban Trading Company have prepared many subjects of scientific and general interest, and in this short account of their resources explain how the instrument may be used to teach geography, in which its great importance will at once be obvious, history, and some branches of technical and industrial science. In matters of state the cinematograph may be used as an aid to the recruiting agent, and also to take records in military and naval manœuvres, while in science its value in operative surgery cannot be called in question, and in the course of a few years important developments in its use may be expected.

Nitrate Facts and Figures. Compiled by A. F. Brodie James, F.S.S. London: Fredc. C. Mathieson and Sons. 1907.

With a view to helping the investor to compute upon a sound basis the actual value of the shares of various nitrate companies, and the return he may expect if he puts his money in them, the compiler of these tables has brought together details as to the companies now in existence and their directors, tabulating the date of formation, the capital, dividend, and reserve funds, together with information relating to the output, &c. Possibly the publication of the report, which places the English public upon an equality with that of South America as far as access to details is concerned, will act beneficially upon the development of nitrate companies here, by giving investors a feeling of security, or at any rate a knowledge of the risks they are running.

The Workmen's Compensation Act, 1906. Handy Notes for Employers. By A. F. O. Walbrook. London: Law, Car, and General Insurance Corporation, Limited.

These notes upon the Workmen's Compensation Act, 1906, endeavour to throw some light upon the interpretation of an act which, in the author's opinion, is full of difficulties like its predecessors. Without laying any claim to be an exhaustive discussion of the provisions of the act, the notes show clearly what persons are entitled to compensation, and what accidents carry compensation, also the amount which the employer may be called upon to pay in the event of the partial or total disablement or death of an employee. The author emphasises the far reaching effects which the act may have, and the notes will help employers to decide what their liabilities are, and also what should be the provisions of a satisfactory insurance policy.

Post's Chemisch-Technische Analyse. ("Post's Technical Analytical Chemistry"). Edited by Dr. Bernard Neumann. Vol. I., Part II. Braunschweig: Friedrich Vieweg und Sohn. 1907.

This analytical handbook gives a summary of laboratory as well as technical methods of investigating the raw material and products of various industries, and as a wide view is taken of the subject the book has a value much above that of a mere laboratory guide; in fact, it may be regarded as a valuable work of reference for the library shelves, as well as a trustworthy practical book. The different sections have been written by authors whose names are in all cases a sufficient guarantee of the accuracy and completeness of the parts for which they are individually responsible. The second part of volume I. contains a section on Illuminating Gas, written by Dr. Julius Becker, in which he discusses the analysis of coal and of gas, and also the determination of the illuminating power of the latter by photometric methods. The examination of calcium carbide and acetylene is treated by Prof. J. H. Vogel, and petroleum, paraffin, and allied substances by Prof. Engler and Dr. Ubbelohde. The last section of the book, written by Dr. Fahrion, is devoted to the fats and fatty oils, glycerin, soaps, and candles, and gives short accounts of the most satisfactory methods of analysing and examining these products for adulterations and impurities. Throughout the book the illustrations are very clear, and since the dimensions are usually indicated they should give real assistance in setting up apparatus in the most convenient form and size.

L'Énergie. ("Energy"). By Alphonse Cruz. Second Edition. Amiens T. Jeunet. 1907.

In this pamphlet the author discusses and criticises at some length the theories advocated in G. le Bon's book, "L'Evolution de la Matière," devoting his attention more especially to the hypothesis that energy and matter are two different aspects of the same thing. He suggests that as energy without mass and movement is impossible, and as these things are the two essential properties of matter, matter and energy are not different manifestations of the same thing, but are actually identical, the only difference that can be assigned to the words being that "matter" is used when all the properties of matter are taken into consideration, while "energy" is used when only its

dynamical properties are considered. The working out of the hypothesis is somewhat involved, and the author's views do not appear to lend themselves readily to satisfactory explanation within the limits of a small pamphlet, while the introduction of brief allusions to such subjects as Prof. Korn's work on telephotography merely complicates matters without really throwing any light upon the theory.

Studies in Plant and Organic Chemistry, and Literary Papers. By Helen Abbott Michael (Miss Abbott). With Biographical Sketch. Cambridge, Massachusetts: The Riverside Press. 1907.

It is perhaps unnecessary to emphasise the importance of Miss Abbott's work on Plant Chemistry, for most students of botany, physiology, and chemistry are familiar with her systematic studies of the analysis of plants and of the relations of chemical composition to plant species. In this volume are collected for the first time her scientific and literary papers, and they form a remarkable record of work done in a comparatively short life. The papers include reprints from the *Berichte der Deutschen Chemischen Gesellschaft* upon a new method of preparing aromatic nitriles, and on mandelic and crotonic acids, as well as various lectures upon different questions connected with plant chemistry. All her work shows a marked power of seeing all sides of a question, while the style of writing is straightforward and decisive; it must have required a sustained effort of steady application, such as is generally not supposed to be associated with brilliance of intellect, to carry her through the monotony of much of her work, and only a truly great investigator would have been unencumbered by the mass of detail she accumulated and have deduced the underlying generalisations.

When the reader turns to the biographical sketch the book contains he will find many surprises awaiting him. The characteristic features of Miss Abbott's work we have touched upon, and it is not a matter of difficulty to conjure up an outline of a personality by whom this work could have been produced, but the result will very probably be totally different from the true individual described in the biography. In place of a patient worker, wrapped up in scientific work, enduring and even plodding, we meet with a charmingly versatile woman, whose sympathies were unbounded and tastes catholic, in whom, among her manifold gifts, the one for scientific work seems almost incidental. Her early years were devoted to the study of music, in which authorities who were eminently qualified to judge considered she was destined to excel; however, in 1882, when 25 years of age, she entered on a course of medicine, which, partly owing to ill-health, she had in turn to relinquish for research work in plant chemistry. In this region she quickly won distinction in American scientific circles, and in 1887 she paid a lengthy visit to Europe. By this time her reputation had spread both in England and on the Continent, and in the course of the tour she made the personal acquaintance of many famous chemists. Her experiences are related frequently in her own words in the biograpical sketch, some notes which she jotted down from time to time, and afterwards copied into a book, having been drawn upon in order to give a view of her impressions of her pilgrimage. All her notes reveal a genuine enthusiasm, keen powers of observation, and abundant vitality, combined with a sense of humour. One particular pleasant feature is the mutual relations which seem in all cases to have existed between her and the many eminent men with whom she came in contact; always we see the same grateful and deferential recognition on the one side of the cordiality manifested on the other. Her philanthropic work, her artistic talent, and finally her literary ability are all characteristic features of her wonderful versatility, the literary papers showing that not only had she read widely, but had also assimilated what she had read and made it her own, while every subject she touched upon was illuminated by the originality of her thoughts and her critical powers of analysis.

The book is one which will appeal to many readers—students of science and literature will find that it contains much to interest them, lovers of biography will enjoy the brightly-told tale of a full and happy life, and to those who believe in the mental powers of women it will give a striking vindication of their beliefs, such as has not perhaps its equal in the history of the achievements of women in the intellectual world.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cxliv., No. 22, June 3, 1907.

Selenium Hexafluoride.—Sir William Ramsay.—Lebeau (*Comptes Rendus*, cxliv., 1042) has suggested that the gaseous compound obtained by Prideaux is an oxyfluoride of selenium, giving as his reason for this suggestion that Prideaux relied upon the density of the gas and its physico-chemical relations with the hexafluorides of sulphur and tellurium. The author has himself determined the density of the gas, which he finds to be 97·23. If the formula were $SeOF_4$ the density would be 85·5, and if SeO_2F_2 it would be 74·5, and thus there appears no room for doubt that it is the compound SeF_6. Possibly in presence of a reducing agent, such as copper, selenium will not form a hexafluoride.

Preparation of a Continuous Current of Oxygen at Constant Pressure.—Gustave D. Hinrichs.—Oxygen may be conveniently prepared for lecture and analytical purposes in a Kipp, charged with large lumps of pyrolusite, which has been well washed to remove all particles of dust. The liquid employed is commercial oxygenated water acidulated with one-twelfth of its volume of concentrated sulphuric acid, which is added slowly, keeping the liquid at a low temperature. The generation of gas is as steady and regular as when hydrogen is evolved by the action of hydrochloric acid upon zinc. It is essential that the solid should be present in excess, and should nearly fill the middle bulb; also the pressure must be relieved when the gas is no longer required.

Action of Silicon Tetrachloride on Silver and Copper.—Em. Vigouroux.—When silver is subjected to the action of silicon tetrachloride at a high temperature, the metal becomes coated with a layer of silver chloride. If this is removed with ammonia, it is found that the loss of weight is 8·33 per cent. The ingot obtained contains no silicon, free or combined. When copper is used it is found that a compound of copper and silicon is obtained, which contains about 2·7 per cent of silicon, corresponding to $Cu_{16}Si$. The copper thus treated retains its malleability and its red colour, and is easily attacked by nitric acid, while other acids and alkaline liquids either have no action upon it or else attack it only very slightly.

Transformation of Ethereal Salts of α-Brominated Fatty Acids into Ethereal Salts of α-Iodated Fatty Acids.—F. Bodroux and F. Taboury.—Iodine reacts with magnesium in presence of a large excess of ethyl oxide, giving an ethereal solution of magnesium iodide. This reacts energetically with halogen ethers, and if the product of the reaction is treated with water, the ethereal layer decanted and shaken up with water, the iodated compound is obtained, the general reaction being—

$$2R{-}CHBr{-}COOC_2H_5 + MgI_2 = 2R{-}CHI{-}COOC_2H_5 + MgBr_2.$$

The yield is practically quantitative, and the authors have

prepared by this method ethyl iodo-acetate, ethyl α-iodo-propionate, ethyl α-iodo-butyrate from the corresponding bromine compounds. The iodine compounds decompose rapidly, setting free iodine under the influence of light and heat. At ordinary temperatures they emit very irritating vapours.

Dimethoxyheptane-1 . 7, $CH_3O(CH_2)_7.OCH_3$. — J. Hamonet. — The following reaction occurs when a haloid methyl ether acts upon the magnesium derivative of a polymethylene haloid ether :— $RO(CH_2)_nMgX+XCH_2OR' = MgX_2+RO(CH_2)_{n+1}OR'$; and this is a general method of passing from one homologue to the next above it. This method, however, is tedious when higher homologues are required, and it may be considerably shortened in the case of compounds containing an odd number of carbon atoms if a formic ether, HCO_2R, is substituted for the methylene haloid ether ; a di-ether of a symmetric glycerin is then obtained on addition of water, viz., $RO(CH_2)_nCHOH(CH_2)_nOR$. The di-ether alcohol when treated with phosphorus trichloride gives a chlorinated diether, $RO(CH_2)_nCHCl(CH_2)_nOR$, and if the chlorine is replaced by hydrogen, the compound $RO(CH_2)_{2n+1}OR$ containing $2n+1$ carbon atoms is obtained from the ether containing n carbon atoms. These transformations when applied to dimethylene heptane triol 1 . 4 . 7 and dimethoxychloroheptane, which can be hydrogenated by the action of sodium, give dimethoxy-heptane.

Synthesis of Auramines by Oxalic Ethers.—A. Guyot.—When oxalic ethers condense with tertiary aromatic amines the secondary products of the reaction give with acids an indigo blue aqueous solution of neutral salts. Dilute ammonia precipitates these aqueous solutions, giving not the corresponding hydrol but a tetramethyl-diamidodiphenyl amidoacetic ether according to the equation—

$$\begin{matrix}R_2N-C_6H_4\\R_2N-C_6H_4\end{matrix}\!\!>\!C\!<\!\begin{matrix}Cl\\CO_2R'\end{matrix}+2NH_3 = = NH_4Cl+\begin{matrix}R_2N-C_6H_4\\R_2N-C_6H_4\end{matrix}\!\!>\!C\!<\!\begin{matrix}NH_2\\CO_2R'\end{matrix}.$$

These new substances have all the properties of the leucoauramines, giving a blue coloration with glacial acetic acid, and condensing with the tertiary aromatic amines, giving derivatives of triphenylmethane. Thus, when an equimolecular mixture of dimethyl aniline and ethyl tetramethyldiamidodiphenyl amidoacetate in acetic acid solution is heated for some minutes on a water-bath, ethyl hexamethyltriamidotriphenylacetate is formed quantitatively according to the equation—

$$\begin{matrix}(CH_3)_2N-C_6H_4\\(CH_3)_2N-C_6H_4\end{matrix}\!\!>\!C\!<\!\begin{matrix}NH_2\\CO_2C_2H_5\end{matrix}+C_6H_5-N(CH_3)_2 = = \begin{matrix}(CH_3)_2N-C_6H_4\\(CH_3)_2N-C_6H_4\end{matrix}\!\!>\!C\!<\!\begin{matrix}C_6H_4-N(CH_3)_2\\CO_2-C_2H_5\end{matrix}+NH_3.$$

To pass to the corresponding auramines a dilute solution of potassium ferricyanide can be used, when oxidation is instantaneous.

Action of Magnesium Organic Compounds upon Benzylidene Metamethylcyclohexanone.—Henri de Béville. — If ethyl magnesium iodide is allowed to act upon a concentrated ethereal solution of benzylidene metamethyl-cyclohexanone a thick liquid is obtained ; from it may be separated a crystalline product, the analysis of which shows that it is $C_{16}H_{22}O$. After rectifying the liquid product a colourless liquid is obtained, which appears to be $C_{16}H_{22}$. When propyl magnesium iodide is used the products of the reaction are $C_{17}H_{24}O$ and $C_{17}H_{24}$. In neither case can the hydrocarbon be obtained in a state of purity.

New Type of Diazo-compound. — H. Duval.— Diamidodiphenylmethanedicarbonate of ethyl is diazotised normally in a strongly acid solution at a low temperature, but when the temperature is raised, or when the liquid is not acid enough, a mixed diazo-compound is formed, the equation being—

$$CO_2C_2H_5-C_6H_3-N=N-Cl \quad Cl-N=N-C_6H_3-CO_2C_2H_5$$

$$= CO_2C_2H_5-C_6H_3-N=N-C(=)N-N=C-C_6H_3-CO_2C_2H_5 + 2HCl.$$

Hot sulphuric acid acts upon the diazodiphenylmethane-dicarbonate of ethyl, giving a compound which may be represented by the formula—

$$CO_2H-C_6H_3-N=N-CH=HO-C_6H_3-CO_2H,$$

or—

$$CO_2H-C_6H_3-N-NH-C(=)HO-C_6H_3-CO_2H.$$

The reactions of the substance leave no room for doubt that the first formula is the correct one, and that the compound belongs to the class of azo-bodies.

MISCELLANEOUS.

Prize for Life-Saving Apparatus for Use in Noxious Atmospheres.—The Council of the Society of Arts are prepared to award, under the Fothergill Trust, a Gold Medal, or a prize of £20, for the best portable apparatus or appliance for enabling men to undertake rescue work in mines or other places where the air is noxious. It is intended that the apparatus sent in shall be submitted to practical trials and tests. In the award of the Medal regard will be had, firstly, to excellence of design and contrivance, and, secondly, to excellence of manufacture. Credit will be given to such parts of the apparatus as are the invention of the exhibitor ; the object being to distinguish the apparatus which gives the best promise of being practically useful. Inventors intending to compete should send in a notice of their intention together with a full description of their inventions not later than March 31, 1908, to the Secretary of the Society of Arts, John Street, Adelphi, London, W.C., and in cases in which the apparatus has been put into actual use, the experience of such use should be given, and the special points of merit of the apparatus indicated. Notice of the place to which the apparatus is to be sent will be subsequently sent to those competitors whose apparatus the judges may desire to test, together with an indication of the tests, and of the manner in which they will be conducted. Competitors intending to patent their inventions should be careful to obtain protection, as the Council of the Society cannot undertake any responsibility as regards the secrecy of the whole, or of any part, of an invention submitted to them. The prize will be awarded on the report of judges appointed by the Council. The competition is not limited to British subjects. The Council reserve to themselves the right of withholding the prize, of extending the time for sending in, or of awarding a smaller prize or smaller prizes.—Henry Trueman Wood, Secretary.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertisement columns.

Microbes in Soil.—Can any reader kindly point me to an authority for the remarkable statement which I have seen (but have tried in vain to recall where) that the organisms in soil where grass is grown are anaërobic, not aërobic, as in the case of other plants.—Quest.

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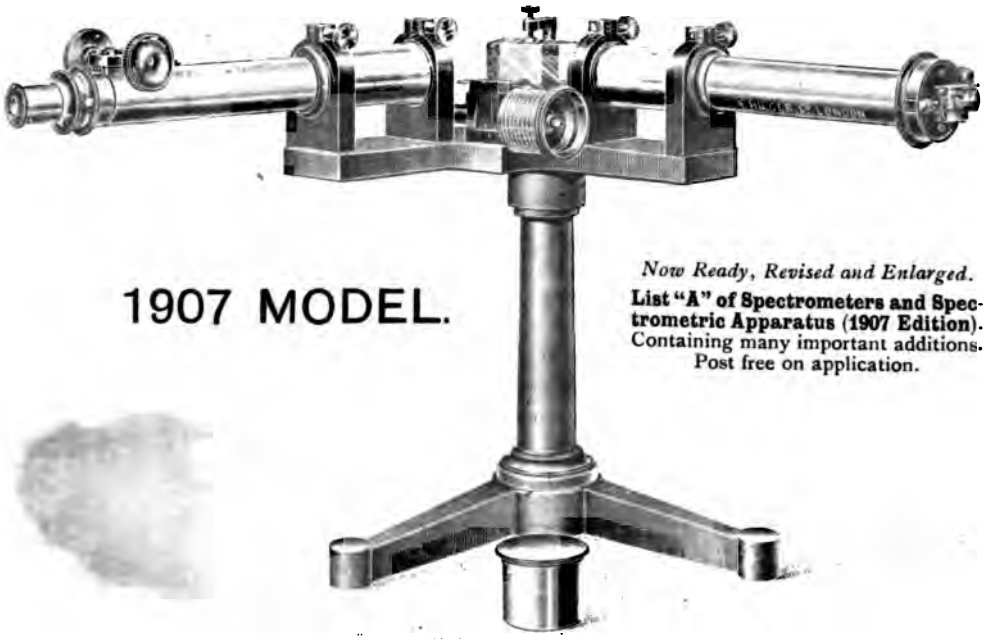

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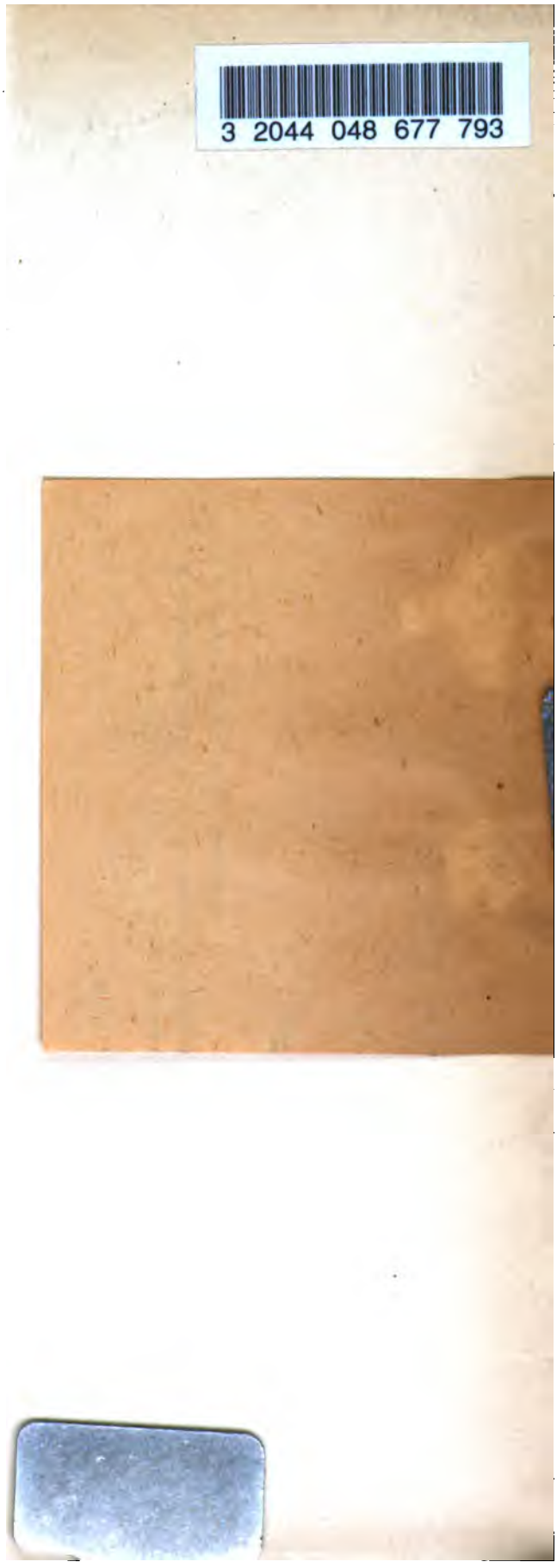
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